EXAMINATION OF FEDERAL AND STATE SCIENCE AND TECHNOLOGY PROGRAMS AS VIEWED FROM A MIDWESTERN PERSPECTIVE

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
SCIENCE, SPACE, AND TECHNOLOGY
HOUSE OF REPRESENTATIVES

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

FEBRUARY 10, 1989

[No. 27]

Printed for the use of the
Committee on Science, Space, and Technology

U.S. GOVERNMENT PRINTING OFFICE

97-750 WASHINGTON : 1989

For sale by the Superintendent of Documents, Congressional Sales Office
U.S. Government Printing Office, Washington, DC 20402

H701-71

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

ROBERT A. ROE, New Jersey, *Chairman*

GEORGE E. BROWN, JR., California
JAMES H. SCHEUER, New York
MARILYN LLOYD, Tennessee
DOUG WALGREN, Pennsylvania
DAN GLICKMAN, Kansas
HAROLD L. VOLKMER, Missouri
HOWARD WOLPE, Michigan
BILL NELSON, Florida
RALPH M. HALL, Texas
DAVE McCURDY, Oklahoma
NORMAN Y. MINETA, California
TIM VALENTINE, North Carolina
ROBERT G. TORRICELLI, New Jersey
RICK BOUCHER, Virginia
TERRY L. BRUCE, Illinois
RICHARD H. STALLINGS, Idaho
JAMES A. TRAFICANT, JR., Ohio
LEE H. HAMILTON, Indiana
HENRY J. NOWAK, New York
CARL C. PERKINS, Kentucky
TOM McMILLEN, Maryland
DAVID E. PRICE, North Carolina
DAVID R. NAGLE, Iowa
JIMMY HAYES, Louisiana
DAVID E. SKAGGS, Colorado
JERRY F. COSTELLO, Illinois
HARRY JOHNSTON, Florida
JOHN TANNER, Tennessee
GLEN BROWDER, Alabama

ROBERT S. WALKER, Pennsylvania
F. JAMES SENSENBRENNER, JR., Wisconsin
CLAUDINE SCHNEIDER, Rhode Island
SHERWOOD L. BOEHLERT, New York
TOM LEWIS, Florida
DON RITTER, Pennsylvania
SID MORRISON, Washington
RON PACKARD, California
ROBERT C. SMITH, New Hampshire
PAUL B. HENRY, Michigan
HARRIS W. FAWELL, Illinois
D. FRENCH SLAUGHTER, JR., Virginia
LAMAR SMITH, Texas
JACK BUECHNER, Missouri
CONSTANCE A. MORELLA, Maryland
CHRISTOPHER SHAYS, Connecticut
DANA ROHRABACHER, California
STEVEN H. SCHIFF, New Mexico
TOM CAMPBELL, California

HAROLD P. HANSON, *Executive Director*
ROBERT C. KETCHAM, *General Counsel*
CAROLYN C. GREENFELD, *Chief Clerk*
DAVID D. CLEMENT, *Republican Chief of Staff*

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

MARILYN LLOYD, Tennessee, *Chairman*

RICK BOUCHER, Virginia
TERRY L. BRUCE, Illinois
JERRY F. COSTELLO, Illinois
DOUG WALGREN, Pennsylvania
RICHARD H. STALLINGS, Idaho
JAMES A. TRAFICANT, JR., Ohio
HOWARD WOLPE, Michigan
TIM VALENTINE, North Carolina

SID MORRISON, Washington
HARRIS W. FAWELL, Illinois
STEVEN H. SCHIFF, New Mexico
LAMAR SMITH, Texas
PAUL B. HENRY, Michigan

CONTENTS

WITNESSES

	Page
February 10, 1989:	
Hon. Henry J. Hyde, a Representative in Congress from the State of Illinois	8
Bruno Mauer, secretary, Wisconsin Department of Development	15
Jay R. Hedges, director of the Illinois Department of Commerce and Community Affairs	29
Dr. Alan Schriesheim, director, Argonne National Laboratory	55
Terry Montgomery, president, Greater Minnesota Corp	64
Dr. Stephen J. Gage, president, Indiana Corporation for Science and Technology	77
Edward A. Miller, president, National Center for Manufacturing Sciences	89
Egils Milbergs, president, Institute for Illinois	104
Jack T. Knuepfer, chairman, Dupage County Board	141
Ormand J. Wade, president, Ameritech-Bell Group	147
Dr. Bill J. Hunsinger, president, Electronics Decisions, Inc	166
Dr. David L. Morrison, president, IIT Research Institute	184
Donald P. McConnell, general manager, design and manufacturing engineering, Battelle	196
Appendix—Additional statements for the record	219

EXAMINATION OF FEDERAL AND STATE SCIENCE AND TECHNOLOGY PROGRAMS AS VIEWED FROM A MIDWESTERN PERSPECTIVE

FRIDAY, FEBRUARY 10, 1989

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m., Argonne National Laboratory, 362 Auditorium, Chicago, Ill., Hon. Marilyn Lloyd presiding.

Mrs. LLOYD. Folks, if you will take your seats, I believe it is about time to begin our hearing.

The Subcommittee on Energy, Research and Development will come to order.

Good morning, ladies and gentlemen.

It is certainly my pleasure to be here today with distinguished members of our committee, Mr. Richard Stallings, Mr. Harris Fawell, Mr. Jack Buechner, Mr. Steven Schiff, and my good friend, Henry Hyde, whom I have worked so closely with on pro-life legislation before the Congress. He represents the district which I believe is right next to us.

After 8 years of chairing the Energy, Research and Development Subcommittee and several field hearings on technological competitiveness at various sites, I am really delighted that we are doing this hearing today in Argonne, and, finally, I think that the topic is so very timely, certainly the witnesses that you have assembled here are a very, very impressive group.

My interest in harvesting the fruits of basic research in technology development goes back to my very first term in Congress over fourteen years ago. My view that the Government should aggressively move technology from the national laboratory to industry was reinforced when I assumed the chairmanship of this subcommittee in 1981.

With strong support from the full Science, Space and Technology Committee, I was able to improve the climate for government, industry and inter-agency cooperation that leads to rapid technology transfer through the sharing of knowledge.

Many of you here may be familiar with the Stevenson-Wydler Act of 1980. This Act originated with this subcommittee, and it made technology transfer an integral part of the R&D responsibility of the federal laboratories. The Act of 1980 allows small busi-

nesses and non-profit organizations to retain title to inventions that are conceived during work under government contracts.

The Federal Technology Transfer Act of 1986, again initiated by this subcommittee, authorizes federal agencies to permit the director of a government-owned laboratory to enter into cooperative R&D agreements with non-profit organizations and to negotiate licensing agreements for laboratory inventions.

The most recent effort in this area is the National Laboratory Competitiveness Act of 1988, which I introduced last August. A key component of this legislation would define technology transfer as a clear mission of the Department of Energy as well as our national laboratories.

This Act would further catalyze technology transfer by the national laboratories by limiting the Department of Energy approval time to thirty days after the national laboratory director has submitted a recommended cooperative R&D on licensing agreements.

As a member of the House Armed Services Committee, I was also able to put in important language for the defense authorization bill last year, requiring the Secretary of Energy to act within six months on patent waiver requests in our defense programs.

I firmly believe that the major ingredient in technology transfer efforts is the constructive and the cooperative involvement of federal and state governments, federal laboratories, industry and the Congress, and I am pleased that we continue to take steps in the legislative arena to enhance this nation's technology competitiveness.

In our own third district of Tennessee, which is the home of the Oak Ridge National Laboratory, we, too, have embarked on aggressive technology transfer initiatives, and although our program is still in its early stages, we have already signed 30 royalty-bearing licenses with 27 different firms, and these licenses have already produced over $600,000 of fees and royalties, and the important part is over $30 million worth of commercial products.

The mid-America region excels in a wide range of technologies that can shape our nation's future. It is the home of fifteen federal laboratories, many successful technology parks, and it certainly is blessed by top-ranking universities and technology centers. Although this region receives only ten percent of the total federal R&D funds, it is strongly supported by industry investment and state programs that promote economic growth and technology competitiveness.

As a result of this marvelous mix of support, the mid-America states have been awarded numerous patents and small business innovation research grants. This is a shining example of constructive and creative collaboration among the states, the industry, the federal laboratories, and the universities.

I am really impressed with what I have learned about this region. I enjoyed meeting with so many of you last night, and I certainly look forward to hearing from the distinguished witnesses.

I want to tour Argonne this afternoon and make this a real learning experience for as many of us as possible, but before I call our first witnesses, I do want to recognize my colleague, the Honorable Harris Fawell, for his opening remarks.

You are certainly well served. Harris Fawell is one of the most active members of our committee. He is a hard worker and he serves you well.

Harris.

Mr. FAWELL. Well, thank you very much, Madam Chairman.

Today, the Subcommittee on Energy, Research and Development will be examining federal and state science and technology programs as viewed from a Midwestern perspective.

As a representative from Illinois, I believe that this hearing is both important and timely, also very appreciative, of course, that Congresswoman Marilyn Lloyd, our chairman for the Energy, Research and Development Subcommittee, has graciously consented to take her valuable time to be with us here in Illinois. Actually, she came in last night and missed that State of the Union or whatever that State of the Budget message was, and——

Mrs. LLOYD. It looked good on television. We did not miss it.

Mr. FAWELL. I have read several newspapers this morning about it, too.

Thank you very much.

I told her on numerous occasions that the center place of the universe is Argonne National Lab, and it is just awfully good to have you here, and she will be also touring Fermi tomorrow. So, I appreciate this very, very much.

We have often heard that the Midwest has been referred to as the "Rust Belt" as if it were unable to compete effectively for high-tech markets of the future, and it is true that the Midwest has borne the brunt of foreign competition, but this is only part of the story.

Across the Midwest, industries are being revitalized. New businesses are being formed and new products are being introduced into the marketplace. Slowly but surely, we are losing the title of "Rust Belt". Instead, the Midwest is becoming a high-technology belt, an advanced manufacturing belt, a bio-technology belt, and an aerospace belt even.

Much of our progress is due to advances in science and technology, but, equally so, much of our progress is due to advances in the way we are organizing and reorganizing our science and technology endeavors. Cooperation is becoming one of the buzzwords of competitiveness. Industries, universities and national laboratories are beginning to work together to develop new technologies to meet the challenges from abroad.

In many cases, federal, state and local technology strategies have made this kind of cooperation possible. The Midwest, I am proud to say, is a living laboratory of the kinds of innovative regional technology strategies that we will need to become competitive again in this great nation of ours.

Our three panels of witnesses will present their views on science and technology programs in the Midwest. Our first panel, consisting of state officials from the region, will discuss some of the science and technology programs that the state governments are pursuing.

The second panel will consist of representatives from different partnership models, which are creating successful cooperative ventures.

Our last panel, consisting of representatives from business and private laboratories, will provide their own views on competitiveness and the policies being developed to meet this challenge.

This hearing will provide Congress with a unique opportunity to examine this quiet revolution in science and technology programs in the Midwest. Just as important, I believe, is the symbol that this hearing provides. We are meeting in the spirit of cooperation and partnership. Democrats and Republicans, officials from federal, state and local governments, and representatives from the public and private sector, have come together to examine these issues.

The Midwest has an exciting story to tell, and I am grateful for the subcommittee's willingness to listen.

In closing, I would like to express my thanks to our witnesses, the Energy, Research and Development Subcommittee, the Institute for Illinois, which has had a great part to play in making all of this possible, Argonne National Laboratory for the hard work they have put in to making this field hearing a reality, and I would, also, of course, like to thank my colleague, Congressman Jack Beuchner of Missouri, who is fast becoming known as the Will Rogers of Congress.

He has that ability to have quotable quotes that seem to stick. I will say things and people do not remember them, but, yet, you seem to have that unique ability of being remembered for what you are saying.

Congressman Richard Stallings from Idaho is my counterpart for Argonne West, and I am glad to have him here, and I got the feeling that I am going to be in Idaho Falls in the future, too, and I look forward to that.

Congressman Steve Schiff from New Mexico is new to the Congress, but I note that he graduated from the University of Illinois. His wife, I might add, is a graduate of the University of Chicago, which operates Argonne, and we feel, although we know, that he is going to well represent New Mexico. He will have a leaning now and then perhaps to the University of Illinois.

Mr. SCHIFF. Excuse me. I do not mean to interrupt, but I just want to say, what they mean is I may now live 1500 miles away from where I was born, but when the subject of Argonne comes up, I am sure I will get a kick under the dinner table if I do something wrong.

Mr. FAWELL. And, of course, my colleague, Henry Hyde. He is in that enviable category in Congress. You do not have to say much about Henry because everyone knows Henry. He has tremendous abilities, and I appreciate, Henry, that you are here to listen and to add your comments in regard to this tremendous topic of competitiveness.

And, again, I want to reiterate my thanks to Madam Chairman for taking your valuable time to be present.

[The prepared opening statement of Mr. Fawell follows:]

HARRIS W. FAWELL
20TH DISTRICT, ILLINOIS
EDUCATION AND LABOR
SUBCOMMITTEES:
LABOR-MANAGEMENT RELATIONS
ELEMENTARY, SECONDARY, AND VOCATIONAL EDUCATION
SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEES:
ENERGY RESEARCH AND DEVELOPMENT
INTERNATIONAL SCIENTIFIC COOPERATION
SELECT COMMITTEE ON AGING

CANNON HOUSE OFFICE BUILDING
(202) 225-3515
CONGRESSIONAL DISTRICT OFFICE
110 W. SIXTH STREET
SUITE 100
CLARENDON HILLS, IL 60514
(312) 655-2052

Congress of the United States
House of Representatives
Washington, DC 20515

OPENING STATEMENT OF CONGRESSMAN HARRIS W. FAWELL

Field Hearing, Subcommittee on Energy Research and Development

February 10, 1989

TODAY THE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT WILL BE EXAMINING FEDERAL AND STATE SCIENCE AND TECHNOLOGY PROGRAMS, AS VIEWED FROM A MIDWESTERN PERSPECTIVE. AS A REPRESENTATIVE FROM ILLINOIS, I BELIEVE THAT THIS HEARING IS BOTH IMPORTANT AND TIMELY. I AM ALSO VERY APPRECIATIVE OF THE FACT THAT CONGRESSWOMAN MARILYN LLOYD, OUR CHAIRMAN FOR THE ENERGY RESEARCH AND DEVELOPMENT SUBCOMMITTEE, HAS GRACIOUSLY CONSENTED TO TAKE HER VALUABLE TIME TO CHAIR THIS HEARING, AS WELL AS LATER TOURING ARGONNE AND FERMI LABORATORIES.

WE HAVE OFTEN HEARD THE MIDWEST REFERRED TO AS THE "RUST BELT," AS IF IT WERE UNABLE TO COMPETE EFFECTIVELY FOR THE HIGH-TECH MARKETS OF THE FUTURE. IT IS TRUE THAT THE MIDWEST HAS BORNE THE BRUNT OF FOREIGN COMPETITION. BUT THIS IS ONLY PART OF THE STORY. ACROSS THE MIDWEST, INDUSTRIES ARE BEING REVITALIZED, NEW BUSINESSES ARE BEING FORMED, AND NEW PRODUCTS ARE BEING INTRODUCED INTO THE MARKETPLACE. SLOWLY BUT SURELY WE ARE LOSING THE TITLE OF "RUST BELT." INSTEAD, THE MIDWEST IS BECOMING A "HIGH TECHNOLOGY BELT," AN "ADVANCED MANUFACTURING BELT," A "BIOTECHNOLOGY BELT," AND AN "AEROSPACE BELT."

THIS HEARING WILL PROVIDE CONGRESS WITH A UNIQUE OPPORTUNITY TO EXAMINE THIS "QUIET REVOLUTION" IN SCIENCE AND TECHNOLOGY PROGRAMS IN THE MIDWEST. JUST AS IMPORTANT, I BELIEVE, IS THE SYMBOL THAT THIS HEARING PROVIDES. WE ARE MET HERE IN THE SPIRIT OF COOPERATION AND PARTNERSHIP. DEMOCRATS AND REPUBLICANS, OFFICIALS FROM FEDERAL, STATE AND LOCAL GOVERNMENTS, AND REPRESENTATIVES FROM THE PUBLIC AND PRIVATE SECTOR HAVE COME TOGETHER TO EXAMINE THESE ISSUES. THE MIDWEST HAS AN EXCITING STORY TO TELL, AND I AM GRATEFUL FOR THE SUBCOMMITTEE'S WILLINGNESS TO LISTEN.

IN CLOSING, I WOULD LIKE TO EXPRESS MY THANKS TO OUR WITNESSES, THE ENERGY RESEARCH AND DEVELOPMENT SUBCOMMITTEE, THE INSTITUTE FOR ILLINOIS, AND ARGONNE NATIONAL LABORATORY FOR THE HARD WORK THEY HAVE PUT INTO MAKING THIS FIELD HEARING A REALITY. I WOULD ALSO LIKE TO THANK MY COLLEAGUES - CONGRESSMAN JACK BUECHNER OF MISSOURI, CONGRESSMAN RICHARD STALLINGS OF IDAHO, CONGRESSMAN STEVEN SCHIFF OF NEW MEXICO, AND CONGRESSMAN HENRY HYDE OF ILLINOIS - FOR TAKING TIME OUT OF THEIR BUSY SCHEDULES TO ATTEND THIS HEARING. FINALLY, I WOULD LIKE TO EXPRESS MY SPECIAL THANKS AGAIN TO OUR CHAIRMAN, CONGRESSWOMAN MARILYN LLOYD, FOR HER LEADERSHIP AND HER WILLINGNESS TO HOST THIS FIELD HEARING.

THANK YOU, MADAM CHAIRMAN.

Mrs. LLOYD. We are all delighted to be here, Harris.

Richard, do you have any opening remarks you would like to make? I know you do.

Mr. STALLINGS. I will make them very brief.

I am pleased to be here. I promised the good folks at Argonne on a number of occasions that I would try to get to Chicago to see their facilities.

My folks in Idaho are still a little bit competitive with this part of the service. They are not sure exactly who runs the show and who does all the hard work, and there is a certain argument that can be made that Idaho Falls really carries a large share of the load here. It is good for me to be here.

I appreciate on the record Harris's commitment to come to Idaho Falls, and we will definitely keep him to that.

The subject that you have developed, this technology transfer and competitiveness in the Midwest, is something that I am very interested in because, obviously, the Far West, their economy is based upon agriculture, has been looking at this whole subject of technology transfer.

We sit around a major federal laboratory in Idaho Falls, and, yet, we have probably done the poorest job nationally of developing the technology that has come from that facility, and, so, you are sort of the pioneers. People look very closely at how you are doing and what you are doing and, hopefully, be able to learn something from that experience.

But I do appreciate this opportunity to be here, Madam Chairman. This is, I think, a real service to bring the subcommittee here and to participate in this hearing. This is certainly where the future of America lies.

Mrs. LLOYD. And, Richard, we promise we are going to come to your district when it warms up.

Jack?

Mr. BEUCHNER. Thank you, Madam Chairman, and as Will Rogers would have said, it is always nice to be in Chicago in January. I brought my own cold. I did not want to take one back with me that you produced. It is February. George Bush last night said he "weren't good on dates either". So, I would like to say, though, that what the President addressed last night in the State of the Budget, where he emphasized the need for increased funding for science and increased funding for education, happened to be two of the benchmarks of what Harris was talking about, and that is, to make the Midwest, the old Rust Belt, into a high-tech area.

My home district in St. Louis County is the world's headquarters for McDonnell-Douglas, an aerospace leader, Monsanto Corporation, with its new bio-technology center. The idea of partnerships is something I am acutely interested in because of the work that Washington University has done with private enterprise and government sectors in my area, and I know that what we will come out of here with we will be able to take back to our committee and, hopefully, do some of the things that have been so well exampled here at Argonne, and maybe use that as prototypes for the rest of this country.

Obviously, where we are in the world, in the highly-competitive area of technology, that whatever we can produce at Argonne and

we can replicate throughout our industries and our technologies throughout this United States, will make us even better in the competitive society, but probably more than that, it will make it a better world in which we live.

So, thank you very much for allowing me to be here with you today.

Mrs. LLOYD. Thank you, Jack.

Steve?

Mr. SCHIFF. Thank you, Madam Chairman.

I would again reiterate that it is good to be back home, even though home for me was the Northside of Chicago, and where my wife and I grew up.

I just want to add a serious word, and that is, Mrs. Lloyd said at the outset that when we are meeting just privately, that there really is not a place for partisanship in the scientific development of the nation, and I was very appreciative of hearing that. I am in full agreement and wish to cooperate as a freshman with Mrs. Lloyd and all the other members of the subcommittee.

I will go one further than that. I do not think there is room for geographical parochialism either. I do not think it is a matter of what advances Argonne National Laboratory necessarily hurts Sandia National Laboratory, which is in my district. I think anything that advances one of us advances all of us.

However, I would conclude by adding that since I went to Idaho Falls in January with Congressman Richard Stallings, and I am here now, I am sure you gentlemen will enjoy coming to Albuquerque with me at some date to be arranged.

Mrs. LLOYD. Thank you very much.

Now, one of my heroes, Henry Hyde.

STATEMENT OF HON. HENRY J. HYDE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF ILLINOIS

Mr. HYDE. Thank you, Marilyn.

I will be extremely brief.

I do not serve on this committee, but I am here in sort of an honorary capacity because this part of the county and this part of the state is very important to me.

I want to say something in a parenthetical way. Congress has recently come in for some outrageous criticism, pejorative remarks, demeaning the office and the people. I think you will see today a panel of congressmen and a congresswoman who give an awful lot more than they get for public service. The caliber of people who are dedicated to the very important issues of government in our country, and not the least of which here in the Science, Space, and Technology Committee, trying to develop methods and means and ways whereby the Federal government can be a partner, a facilitator, in harnessing the science and the technology brains and creativity and innovation that this country has in abundance.

America's ace in the hole, its long suit, is its ability in the fields of science and technology. Government should be a facilitator in that important role bringing together of all those elements, so that the quality of life not only for ourselves but for the rest of the world can be improved, and it takes intellect, it takes the will and

determination to get to the bottom of the many issues and the controversies and find the best ways to resolve them.

This is the type of subcommittee that I am very proud of. Marilyn Lloyd from Tennessee, Steve Schiff from Albuquerque, Jack Beuchner from Missouri, Harris Fawell, who is just such a delight to serve with Harris, who is so intense and so involved and immersed in the important work that he does on Science, Space, and Technology and Education and Labor, and Marilyn Lloyd, who for years has been the spokesperson for Oak Ridge, Tennessee, and for nuclear energy and for all of the problems that we have both past, present and are sure to have in the future with America's enormous energy consumption and the availability of it.

So, these are great people that you have here. I am proud to serve with them, and thank you for permitting me to sit in.

Mrs. LLOYD. Thank you very much, Henry.

Before we get on to our witnesses, I would like to introduce Kitty Rising and Kathy Smith that have worked so hard from the Science staff to make this hearing a reality. They are the ones that did all the work and had all the papers in front of them and responsible for this hearing being the great success I am sure it will be today.

Our first panel consists of three witnesses. I believe one is going to be a little bit late. From the states of Illinois and Wisconsin, we had originally invited seven mid-America states, including Illinois, Wisconsin, Minnesota, Iowa, Michigan, Pennsylvania, and Indiana.

Unfortunately, most of the Governors, and their designees had schedule conflicts and could not make it today. This is the time, of course, that many define their budget requests. I certainly can understand this because our subcommittee is dealing with the budget numbers as well.

But mid-America does have very aggressive state programs to pursue economic competitiveness and the extensive cooperation between the states is exemplary.

We will be hearing about the state strategy, the programs, and the initiatives to promote technological innovation and their views on the R&D funding programs as well as their priorities.

Mr. Jay Hedges, Director of Illinois Department of Commerce and Community Affairs, I understand, is here. I understand Mr. Jack Knuepfer, Chairman of the DuPage County Board, will be a little bit late. We are looking forward to his testimony, though.

Unfortunately, Mr. Andrew Greenberg is ill today. He is Secretary of Commerce in the Pennsylvania Department of Commerce.

Mr. Bruno Mauer is here. Good to see you. Secretary to the Wisconsin Department of Development.

Also, I would like to point out that Governor Evan Bayh of Indiana is submitting testimony for the record.

[The prepared statement of Governor Bayh follows:]

Hearings before the

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

ARGONNE NATIONAL LABORATORY

Argonne, Illinois

Testimony of

The Honorable Evan Bayh

Governor

State of Indiana

February 10, 1989

Madame Chairperson, Distinguished members of the Subcommittee:

I am pleased to join my fellow midwestern governors in welcoming the subcommittee and in applauding your efforts to understand the perspectives and priorities of our states on science and technology. I appreciate this opportunity to describe Indiana's strategy for promoting technological innovation and improving the competitiveness of its businesses and industries. In passing, I will also comment on several areas where federal policies and programs affecting our efforts within Indiana could be improved.

In Indiana, we recognize that one of the greatest challenges facing our state and the nation today is how to compete successfully in the global economy. We have learned that we cannot stand by passively and allow the changes being forced by our foreign competitors to wash over us. We know that we must confront these changes in many ways: by aggressively encouraging increased export of goods manufactured in our plants; by promoting greater cooperation in marketing, research, and training among our manufacturers; by helping our manufacturers determine their technology needs and acquire the needed technology; by fostering new product innovation and technology transfer; and by assisting small businesses to grow and create new products and jobs.

During the next four years, Lt. Governor Frank O'Bannon, who serves as the head of Indiana's Department of Commerce, and I will be working closely with Indiana-based companies and agriculture to expand exports. We already have several programs in place in Indiana to help develop exports and to facilitate their financing. We are now concentrating on making them work effectively for more Indiana companies. The noteworthy cooperative effort between the U.S. Department of Commerce and the state, for example, to promote export trade by Indiana companies is beginning to show results. While I am encouraged by the progress that we have made in this area, we need to accelerate our pace in export expansion because our competitors show no signs of letting up.

Another way to improve the competitive position of Indiana manufacturers is to promote cooperative efforts among them, much as our foreign competitors have done successfully for years. To this end, we have proposed the creation of an Indiana Strategic Development Fund. The Fund will direct loans and grants to industrial sectors of the state's economy which are critical to our long-term economic health. To qualify for the fund, Indiana companies must agree to cooperate in joint efforts such as export marketing, research and development, and worker training.

To compete in the world today, we know that we must remain at the forefront of technology development and application. Indiana is fortunate to have two of the nation's top research universities in Purdue University and Indiana University. We also have a number of major companies which are leaders in their respective fields of technology. And we have one of the most innovative public-private partnerships -- the Indiana Corporation for Science and Technology -- dedicated to fostering technology development and technology transfer.

As you will hear later from the CST president, Dr. Stephen Gage, the Corporation invests approximately three-fourths of the $10 million provided annually by the General Assembly to support the development of new technology-based products. Much of this development then is carried out by new, startup Indiana companies. With their new products come new profits, new diversified jobs, and new tax revenues. CST also provides support to five university-based research centers in such critical areas as biotechnology, opto-electronics, and superconductivity. Since these centers all involve Indiana companies, the companies have access to some of the most advanced capabilities and research results available today. Technology transfer occurs as an integral part of the process.

I am pleased that Argonne National Laboratory has been assigned an important role in advancing the commercialization of superconductor technologies. I appreciate the efforts that ANL has made to involve Indiana's Superconductivity Center in the Laboratory's programs. It is encouraging to see that Argonne is beginning to understand its responsibilities to all of the states in this region. I also strongly support enhanced efforts, such as Argonne's, to make available research results from the federal laboratories to the industrial sector. To regain our national competitiveness, we must ensure that maximum effective use is made of all of our national investments.

To get even more leverage from both state and private funds invested in Indiana's universities and private companies, I have directed the Corporation for Science and Technology to develop a long-range technology strategy for the state. This plan will take into account federal programs, policies, and actions so that Indiana can take full advantage of all available opportunities.

We are also very aware that many of Indiana's small and medium-sized manufacturing companies need assistance in keeping up with rapid changes in technologies, markets, and management. We are encouraged by the new Manufacturing Technology Center Program administered by National Institute of Standards and Technology. We are pleased that the Congress has supported the

establishment of three regional centers, however, we are concerned because such a limited program ignores the needs of manufacturers in Indiana and in most of the other Mid-America states.

A few Indiana programs such as Purdue University's Technical Assistance Program have been underway for several years and have helped a number of companies solve product and process-related problems. But we need to significantly broaden our base of technical support to the state's 8000 small and medium-sized manufacturing companies. The Corporation for Science and Technology is currently operating a pilot program to determine how best to help these companies identify their technology needs and to link the companies with the appropriate resources to assist them in the acquisition and integration of productivity-enhancing equipment and procedures. I have asked CST to begin planning to expand this pilot program into a state-wide Indiana Manufacturing Excellence Extension Service.

We recognize that one of the most dynamic forces in Indiana's economy is the entrepreneurial small business. Such small businesses, including those which are concentrating on technology-based products and services, create the majority of new jobs and generate new products and services that can spawn whole industries. But many new businesses fail in the critical first year. Because business incubators can ease many of the difficulties encountered by new businesses, we are proposing a Small Business Incubator Program to provide matching funds to local organizations that establish incubators. In addition, we are seeking funding for Indiana's Seed Capital Revolving Fund with special emphasis on making a portion of the funds of local seed capital organizations receiving state assistance available to businesses owned by minorities and women. We are confident that these two measures will encourage more as well as a broader cross-section of entrepreneurs to help build Indiana's economic future.

An increasingly important source of funding for Indiana companies is the federal Small Business Innovative Research (SBIR) program. SBIR awards contributed significantly in funding the startup phase of several promising companies that CST is now helping enter the market. In general, these awards seem to be excellent investments of federal R&D funds and serve to involve many innovative companies otherwise excluded from federal R&D programs. For these reasons, I would encourage the Congress to give serious consideration to increasing the percentage of federal R&D funds reserved for SBIR awards in the various federal agencies.

Finally, in the long run, we recognize that Indiana's future depends on our strongest asset and our most valuable resource -- our children. The dramatic changes occurring in our society require, more than ever before, that our children are better prepared to enter college or the world of work. This means that they must master not only the basic skills but also must learn how to learn throughout their lives. Through our Excel Program for educational excellence, I am introducing a number of new incentives to help improve the general level of K-12 education across the state and specifically to encourage a greater emphasis on mathematics, science, and technology.

Thank you for this opportunity to tell you about Indiana's programs to improve industrial competitiveness and innovation. I am pleased that the subcommittee held this hearing here in Mid-America. I would encourage you to return again soon because some of the most innovative ideas are being developed here, as they have been before, in the midwestern "laboratories of the states."

Mrs. LLOYD. I think it is also noteworthy that the original Bayh-Dole Technology Transfer Act was co-authored by the Governor's father, Birch Bayh.

Gentlemen, we are delighted to have you. You may proceed with your testimony. We look forward to hearing from you.

Mr. Mauer.

Mr. MAUER. Who would you like to go first?

Mrs. LLOYD. I think you are first.

Mr. MAUER. Thank you.

Good morning.

Oh, bad start.

Mrs. LLOYD. Good morning.

Mr. MAUER. Can we try it once more?

Mrs. LLOYD. Good morning.

Mr. MAUER. Good morning.

All. Good morning.

STATEMENT OF BRUNO MAUER, SECRETARY, WISCONSIN DEPARTMENT OF DEVELOPMENT

Mr. MAUER. OK. My name is Bruno Mauer. I am Secretary of the Department of Development for the State of Wisconsin, and I wish to extend a personal greeting from Wisconsin's Governor, Tommy Thompson, to Chairperson Marilyn Lloyd and other members of the Energy Research and Development Subcommittee, as well as to the other speakers and to all of you as honored guests.

Now, for clarity's purpose, I would like to let everybody know to avoid that confusion, Big Jim Thompson is Governor of Illinois and Tough, Tenacious Tommy Thompson is Governor of the State of Wisconsin.

Governor Tommy Thompson and I both applaud your subcommittee's willingness to bring this field hearing to America's Heartland. We commend your desire to hear firsthand mid-America's views on federal, state and private sector priorities from and for science and technology.

While much has been accomplished at the state and local level, we in Wisconsin as well as our neighboring states in the Midwest would undoubtedly agree that much remains to be done if the United States is to regain and to maintain its competitive position in our global economy.

The United States is losing the competitiveness battle. U.S. manufacturing output per worker hour increased only 3.1 percent per year between 1979 and 1985. Japan increased 5.7 percent per year. West Germany increased 3.2 percent per year. France increased 3.8 percent per year, and even the United Kingdom increased its output per worker hour 4.2 percent per year during this same period of time.

The Midwestern states suffer even in comparison to the U.S. average. From 1978 to 1985, the average annual increase in Midwestern manufacturing output per worker was only 1.71 percent.

We all know that an important, if not most important, determinant of worker productivity is the technology sophistication of the capital in the hands of skilled and trained workers.

It is, therefore, absolutely imperative that our universities be on the cutting edge of both basic and applied technology development. It is equally important that as these technologies are developed, they are transferred efficiently to U.S. companies rather than skipping across the seas to be adopted first by our foreign competitors. This suggests both governance and the protection of intellectual property are a serious problem.

If we are to meet these competitive challenges we face in the world marketplace, we must be ready to recognize that state efforts to enhance technology development and transfer are only a partial solution.

While state technology efforts are increasingly important today, they will always be dwarfed in magnitude by those in the private sector and at the federal level.

It is my hope, therefore, that this field hearing as well as other similar opportunities for dialogue throughout our country will result in a better understanding of the appropriate roles in the three-way technology development partnership between the private sector, the states and the Federal Government.

I have a number of specific concerns focusing on federal activities to enhance science and technology development, which I think are worthy of further discussion.

First and most importantly, we need to elevate nationally the public's and the Congress's understanding of the importance of issues related to science and technology.

In the face of on-going federal mega-deficits and a long list of competing budgetary priorities, we simply cannot expect an effective federal response to the technology challenge unless there is a broad and reasonable consensus of its strategic importance.

I served on the President's Commission on Industrial Competitiveness. In our 1985 report, we highlighted the importance of technological development as well as a number of other initiative areas critical to maintaining the United States' competitive position.

Then, and still to this day, our spending priorities are and remain our most elusive and difficult problem.

As expressed last evening in the budget message by and with the support of the President, we need to mount a similar highly-visible national campaign to highlight the singular importance of technological development as a key component of our future national agenda.

This national technology awareness campaign should include participants from industry, the states, the academic community, and the Federal Government. It should highlight a series of specific actions and policy steps which could be taken at the federal level to enhance our technological development.

Let me provide just a few illustrative examples of the kinds of actions and policy recommendations which could be considered.

The federal research and development tax credit was recently reduced from 25 to 20 percent. The R&D tax credit is one of the few incentives which exists to encourage industry participation in research activities with educational institutions. This incentive should be increased, not reduced, and in hearing the President last evening, I believe there is a strong urging in that direction.

The 1988 Trade Act included provisions to modify the mission of the National Bureau of Standards to the creation of the National Institute of Standards and Technology, called NIST. This initiative should be enhanced and fully implemented.

There is currently no appropriation for a $40 million regional manufacturing technology centers program which would be administered by NIST. This appropriation level should be supported to encourage the establishment of several of these centers in the Midwest manufacturing heartland.

The Act also authorizes $2 million for NIST to provide technical and financial assistance to state technology programs. This is a good first step, but, unfortunately, it does not go far enough.

I recommend that a major federal matching grant program be initiated to establish and expand state technology programs. Such a federal program would be particularly beneficial to smaller states, like Wisconsin, which have major world class research universities, but not the state budgetary resources to fully exploit the commercialization of the research conducted at these institutions.

The Federal Government has focused its attention recently on a few important big science initiatives, such as the Superconducting Super Collider, and NSF Centers of Excellence, to name just a few.

This big science approach is laudable in that it provides a strategic focus to federal science and technology spending. However, we should not ignore smaller science. There are thousands of smaller commercially-beneficial research and development initiatives which should not be forgotten as we pursue these very large pursuits.

The SBIR Program is just one example of a well thought-out program which encourages commercially-viable smaller science. The SBIR Small Business Set-Aside for extra-mural R&D projects by major federal agencies should be increased from the existing level of 1.25 percent up to at least 3 percent. This can be accomplished with zero impact on the problems with our federal budget.

Another concern I have is the inability of the federal bureaucracy to handle new technologies. The U.S. Patent Office currently has on file over 7,000 bio-technology patent applications with an approximately thirty-month processing period.

The Patent Office promises to reduce the review period to eighteen months by 1992. I believe 1992 is too long to wait. We must accelerate this patent process.

I have similar concerns with the delays experienced by bio-technology companies as they deal with the Environmental Protection Agency's regulatory field testing programs.

Prudent regulation is necessary to protect the public interests, but unnecessary delays are a serious impediment to the commercialization of important new technologies.

We are also unwilling to realistically evaluate cost benefits in a culture that is rapidly becoming more and more risk adverse. I am concerned that we will pay a very steep price for this changing behavior pattern.

A final technology policy area which deserves further study is the issue of intellectual property. The legal profession has worked its way into the research and development arena. While intellectual property rights are important in that they provide incentives for

commercialization, my concern is that we may place impediments in the way of efficient technology transfer.

While this is a rather arcane area, the stakes are high enough that further study is warranted.

These are a few issues which are illustrative of what could be considered in a federal technology development policy. I hope that they can be used as a point of departure by your subcommittee in its deliberations.

I further hope that your subcommittee can play a key role in the elevation of these and other issues related to science and to technology, to their proper positioning in the federal agenda for up and coming years, for it most certainly is needed and warrants your great attention.

Thank you very much.

[The prepared statement of Mr. Mauer follows:]

COMMENTS BY

BRUNO MAUER, SECRETARY

WISCONSIN DEPARTMENT OF DEVELOPMENT

BEFORE THE HOUSE SUBCOMMITTEE ON

ENERGY, RESEARCH AND DEVELOPMENT

ARGONNE NATIONAL LABORATORY

ARGONNE, ILLINOIS

FEBRUARY 10, 1989

GOOD MORNING. MY NAME IS BRUNO MAUER. AS SECRETARY OF THE WISCONSIN DEPARTMENT OF DEVELOPMENT, I WISH TO EXTEND A PERSONAL GREETING FROM WISCONSIN'S GOVERNOR TOMMY G. THOMPSON TO CHAIRPERSON MARILYN LLOYD, OTHER MEMBERS OF THE ENERGY, RESEARCH AND DEVELOPMENT SUBCOMMITTEE, AS WELL AS TO SPEAKERS AND HONORED GUESTS. GOVERNOR THOMPSON AND I BOTH APPLAUD YOUR SUBCOMMITTEE'S WILLINGNESS TO BRING THIS FIELD HEARING TO AMERICA'S HEARTLAND. WE COMMEND YOUR DESIRE TO HEAR FIRSTHAND MID-AMERICA'S VIEWS ON FEDERAL, STATE, AND PRIVATE SECTOR PRIORITIES FOR SCIENCE AND TECHNOLOGY.

ECONOMIC DEVELOPMENT IS GOVERNOR THOMPSON'S NUMBER ONE PRIORITY. A KEY COMPONENT OF WISCONSIN'S ECONOMIC DEVELOPMENT STRATEGY IS TECHNOLOGY DEVELOPMENT AND TRANSFER. WISCONSIN'S MAJOR PUBLIC AND PRIVATE UNIVERSITIES, AS WELL AS OUR VOCATIONAL AND TECHNICAL COLLEGES, ALL PROVIDE TECHNOLOGY TRANSFER PROGRAMS TO ENCOURAGE PRIVATE SECTOR APPLICATION OF NEW TECHNOLOGIES. WISCONSIN'S TECHNOLOGY DEVELOPMENT FUND CAN PROVIDE UP TO $21 MILLION DOLLARS BIENNIALLY IN MATCHING GRANTS TO INDUSTRIES TO FUND UNIVERSITY RESEARCH TO DEVELOP NEW PRODUCTS AND PROCESSES. DURING THE PAST YEAR, WE ESTABLISHED A NEW SBIR PROMOTION AND TECHNICAL ASSISTANCE PROGRAM. WE HAVE ALSO HAVE A $600,000 BIENNIAL APPROPRIATION FOR AN SBIR BRIDGE GRANT PROGRAM TO PROVIDE CONTINUITY BETWEEN SBIR PHASE I AND PHASE II GRANTS.

IN HIS BUDGET MESSAGE LAST WEEK, GOVERNOR THOMPSON UNVEILED A COMPREHENSIVE FIVE-POINT PROGRAM TO ENHANCE WISCONSIN'S BIOTECHNOLOGY INDUSTRY. THE STATE BUDGET ALSO PROPOSES THE ESTABLISHMENT OF A TECHNOLOGY DEVELOPMENT CENTER WITHIN THE DEPARTMENT OF DEVELOPMENT WHICH WILL PROVIDE TECHNOLOGY EVALUATION, ASSISTANCE AND REFERRAL SERVICES TO SMALL AND MEDIUM-SIZED MANUFACTURING COMPANIES.

WHILE MUCH HAS BEEN ACCOMPLISHED AT THE STATE AND LOCAL LEVEL, WE IN WISCONSIN, AS WELL AS OUR NEIGHBOR STATES IN THE MIDWEST WOULD UNDOUBTEDLY AGREE THAT MUCH REMAINS TO BE DONE IF THE UNITED STATES IS TO REGAIN AND MAINTAIN ITS COMPETITIVE POSITION IN THE GLOBAL ECONOMY.

THE UNITED STATES IS LOSING THE COMPETITIVENESS BATTLE.

U.S. MANUFACTURING OUTPUT PER WORKER HOUR INCREASED ONLY 3.1 PERCENT PER YEAR BETWEEN 1979 AND 1985. JAPAN INCREASED 5.7 PERCENT PER YEAR, WEST GERMANY INCREASED 3.2 PERCENT PER YEAR, FRANCE INCREASED 3.8 PERCENT PER YEAR, AND EVEN THE UNITED KINGDOM INCREASED ITS OUTPUT PER WORKER-HOUR 4.2 PERCENT PER YEAR DURING THE SAME TIME PERIOD.

THE MIDWESTERN STATES SUFFER EVEN IN COMPARISON TO THE U.S. AVERAGE. FROM 1978 TO 1985 THE AVERAGE ANNUAL INCREASE IN MIDWESTERN MANUFACTURING OUTPUT PER WORKER HOUR WAS ONLY 1.71 PERCENT.

WE ALL KNOW THAT AN IMPORTANT, IF NOT THE MOST IMPORTANT, DETERMINANT OF WORKER PRODUCTIVITY IS THE TECHNOLOGICAL SOPHISTICATION OF THE CAPITAL IN THE HANDS OF OUR WORKERS. IT IS ABSOLUTELY IMPERATIVE THAT OUR UNIVERSITIES BE ON THE CUTTING EDGE OF APPLIED TECHNOLOGY DEVELOPMENT. IT IS EQUALLY IMPORTANT THAT AS THESE TECHOLOGIES ARE DEVELOPED, THEY ARE TRANSFERRED EFFICIENTLY TO U.S. COMPANIES RATHER THAN SKIPPING ACROSS THE SEAS TO BE ADOPTED FIRST BY OUR FOREIGN COMPETITORS.

IF WE ARE TO MEET THE COMPETITIVE CHALLENGES WE FACE IN THE WORLD MARKETPLACE, WE MUST BE READY TO RECOGNIZE THAT STATE EFFORTS TO ENHANCE TECHNOLOGY DEVELOPMENT AND TRANSFER ARE ONLY A PARTIAL SOLUTION. WHILE STATE TECHNOLOGY EFFORTS ARE INCREASINGLY IMPORTANT, THEY WILL ALWAYS BE DWARFED IN MAGNITUDE BY THOSE IN THE PRIVATE SECTOR AND AT THE FEDERAL LEVEL. IT IS MY HOPE THAT THIS FIELD HEARING AS WELL AS OTHER SIMILAR OPPORTUNITIES FOR DIALOGUE THROUGHOUT THE COUNTRY WILL RESULT IN A BETTER UNDERSTANDING OF THE APPROPRIATE ROLES IN THE THREE-WAY TECHNOLOGY DEVELOPMENT PARTNERSHIP BETWEEN THE PRIVATE SECTOR, THE STATES AND THE FEDERAL GOVERNMENT.

FOCUSING ON FEDERAL ACTIVITIES TO ENHANCE SCIENCE AND TECHNOLOGY DEVELOPMENT, I HAVE A NUMBER OF SPECIFIC CONCERNS WHICH I THINK ARE WORTHY OF FURTHER DISCUSSION AS THE DAY GOES ON.

- FIRST AND MOST IMPORTANTLY WE NEED TO ELEVATE NATIONALLY THE PUBLIC'S AND THE CONGRESS' UNDERSTANDING OF THE IMPORTANCE OF ISSUES RELATED TO SCIENCE AND TECHNOLOGY. IN THE FACE OF "MEGA-DEFICITS" AND A LONG LIST OF COMPETING BUDGETARY PRIORITES, WE SIMPLY CANNOT EXPECT AN EFFECTIVE FEDERAL RESPONSE TO THE TECHNOLOGY CHALLENGE UNLESS THERE IS A BROAD CONCENSUS OF ITS STRATEGIC IMPORTANCE.

I SERVED ON THE PRESIDENT'S COMMISSION ON INDUSTRIAL COMPETITIVENESS. IN OUR 1985 REPORT WE HIGHLIGHTED THE IMPORTANCE OF TECHNOLOGICAL DEVELOPMENT AS WELL AS A NUMBER OF OTHER INITIATIVE AREAS CRITICAL TO MAINTAINING THE UNITED STATES' COMPETITIVE POSITION.

WITH THE SUPPORT OF THE PRESIDENT, WE NEED TO MOUNT A SIMILAR, HIGHLY VISIBLE, NATIONAL CAMPAIGN TO HIGHLIGHT THE SINGULAR IMPORTANCE OF TECHNOLOGICAL DEVELOPMENT AS A KEY COMPONENT OF OUR FUTURE NATIONAL AGENDA.

THIS NATIONAL TECHNOLOGY AWARENESS CAMPAIGN SHOULD INCLUDE PARTICIPANTS FROM INDUSTRY, THE STATES, THE ACADEMIC COMMUNITY AND THE FEDERAL GOVERNMENT. IT SHOULD HIGHLIGHT A SERIES OF SPECIFIC ACTIONS AND POLICY STEPS WHICH COULD BE TAKEN AT THE FEDERAL LEVEL TO ENHANCE OUR TECHNOLOGICAL DEVELOPMENT. LET ME PROVIDE JUST A FEW ILLUSTRATIVE EXAMPLES OF THE KINDS OF ACTIONS AND POLICY RECOMMENDATIONS WHICH COULD BE CONSIDERED:

- THE FEDERAL R&D TAX CREDIT WAS RECENTLY REDUCED FROM 25 TO 20 PERCENT. THE R&D TAX CREDIT IS ONE OF THE FEW INCENTIVES WHICH EXIST TO ENCOURAGE INDUSTRY PARTICIPATION IN RESEARCH ACTIVITIES WITH EDUCATIONAL INSTITUTIONS. THIS INCENTIVE SHOULD BE INCREASED, NOT REDUCED.

- THE 1988 TRADE ACT INCLUDED PROVISIONS TO MODIFY THE MISSION OF THE NATIONAL BUREAU OF STANDARDS THROUGH THE CREATION OF THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR N.I.S.T.. THIS INITIATIVE SHOULD BE ENHANCED AND FULLY IMPLEMENTED.

  THERE IS CURRENTLY NO APPROPRIATION FOR A $40 MILLION "REGIONAL MANUFACTURING TECHNOLOGY CENTERS" PROGRAM WHICH WOULD BE ADMINISTERED BY N.I.S.T. THIS APPROPRIATION LEVEL SHOULD BE SUPPORTED TO ENCOURAGE THE ESTABLISHMENT OF SEVERAL OF THESE CENTERS IN THE MIDWEST MANUFACTURING HEARTLAND.

  THE ACT ALSO AUTHORIZES $2 MILLION FOR N.I.S.T. TO PROVIDE TECHNICAL AND FINANCIAL ASSISTANCE TO STATE TECHNOLOGY PROGRAMS. THIS IS A GOOD FIRST STEP, BUT IT DOES NOT GO FAR ENOUGH.

I RECOMMEND THAT A MAJOR FEDERAL MATCHING GRANT PROGRAM BE INITIATED TO ESTABLISH AND EXPAND STATE TECHNOLOGY PROGRAMS. SUCH A FEDERAL PROGRAM WOULD BE PARTICULARLY BENEFICIAL TO SMALLER STATES LIKE WISCONSIN WHICH HAVE MAJOR AND WORLD-CLASS RESEARCH UNIVERSITIES, BUT NOT THE STATE BUDGETARY RESOURCES TO FULLY EXPLOIT THE COMMERCIALIZATION OF THE RESEARCH CONDUCTED AT THESE INSTITUTIONS.

- THE FEDERAL GOVERNMENT HAS FOCUSED ITS ATTENTION RECENTLY ON A FEW IMPORTANT "BIG SCIENCE" INITIATIVES SUCH AS THE "SUPER-CONDUCTING, SUPER-COLLIDER;" SEMATECH; AND NSF "CENTERS OF EXCELLENCE" TO NAME JUST A FEW. THIS "BIG SCIENCE" APPROACH IS LAUDABLE IN THAT IT PROVIDES A STRATEGIC FOCUS TO FEDERAL SCIENCE AND TECHNOLOGY SPENDING. HOWEVER, WE SHOULD NOT IGNORE "SMALL SCIENCE." THERE ARE THOUSANDS OF SMALLER COMMERCIALLY BENEFICAL RESEARCH AND DEVELOPMENT INITIATIVES WHICH SHOULD NOT BE FORGOTTEN AS WE PURSUE THESE BIG PROJECTS.

THE SBIR PROGRAM IS JUST ONE EXAMPLE OF A WELL THOUGHT OUT PROGRAM WHICH ENCOURAGES COMMERCIALLY VIABLE "SMALL SCIENCE." THE SBIR SMALL BUSINESS SET ASIDE FOR EXTRA-MURAL R&D PROJECTS BY MAJOR FEDERAL AGENCIES SHOULD BE INCREASED FROM THE EXISTING LEVEL OF 1.25 PERCENT TO 3 PERCENT. THIS CAN BE ACCOMPLISHED WITH ZERO IMPACT ON THE FEDERAL BUDGET.

- ANOTHER CONCERN I HAVE IS THE INABILITY OF THE FEDERAL BUREAUCRACY TO HANDLE NEW TECHNOLOGIES. THE U.S. PATENT OFFICE CURRENTLY HAS ON FILE OVER 7,000 BIOTECHNOLOGY PATENT APPLICATIONS WITH AN APPROXIMATELY 30-MONTH PROCESSING PERIOD. THE PATENT OFFICE PROMISES TO REDUCE THE REVIEW PERIOD TO 18 MONTHS BY 1992. I BELIEVE 1992 IS TOO LONG TO WAIT.

- I HAVE SIMILAR CONCERNS WITH DELAYS EXPERIENCED BY BIOTECHNOLOGY COMPANIES AS THEY DEAL WITH THE ENVIRONMENTAL PROTECTION AGENCY'S REGULATION OF FIELD TESTS. PRUDENT REGULATION MAY BE NECESSARY TO PROTECT THE PUBLIC INTEREST, BUT UNNECESSARY DELAYS ARE A SERIOUS IMPEDIMENT TO THE COMMERCIALIZATION OF IMPORTANT NEW TECHNOLOGIES.

- A FINAL TECHNOLOGY POLICY AREA WHICH DESERVES FURTHER STUDY IS THE ISSUE OF "INTELLECTUAL PROPERTY." THE LEGAL PROFESSION HAS WORKED ITS WAY INTO THE RESEARCH AND DEVELOPMENT ARENA. WHILE INTELLECTUAL PROPERTY RIGHTS ARE IMPORTANT IN THAT THEY PROVIDE INCENTIVES FOR COMMERCIALIZATION, MY CONCERN IS THAT WE MAY PLACE IMPEDIMENTS IN THE WAY OF EFFICIENT TECHNOLOGY TRANSFER. WHILE THIS IS A RATHER ARCANE AREA, THE STAKES ARE HIGH ENOUGH THAT FURTHER STUDY IS WARRENTED.

THESE ARE JUST A FEW ISSUES WHICH ARE ILLUSTRATIVE OF WHAT COULD BE CONSIDERED IN A FEDERAL TECHNOLOGY DEVELOPMENT POLICY. I HOPE THAT THEY CAN BE USED AS A POINT OF DEPARTURE BY YOUR SUBCOMMITTEE IN ITS DELIBERATIONS.

I FURTHER HOPE THAT YOUR SUBCOMMITTEE CAN PLAY A KEY ROLE IN THE ELEVATION OF THESE AND OTHER ISSUES RELATED TO SCIENCE AND TECHNOLOGY TO THEIR PROPER POSITION IN THE FEDERAL AGENDA FOR UPCOMING YEARS.

THANK YOU.

RW:MEM
3949B

Mrs. LLOYD. Thank you very much, Mr. Mauer.
Mr. Hedges, please proceed.

STATEMENT OF JAY R. HEDGES, DIRECTOR OF THE ILLINOIS DEPARTMENT OF COMMERCE AND COMMUNITY AFFAIRS

Mr. HEDGES. Thank you, Chairman Lloyd, and distinguished members of the subcommittee.

My name is Jay Hedges, and I am the Director of the Illinois Department of Commerce and Community Affairs, commonly known as DCCA throughout Illinois.

As Illinois' chief economic development agency, DCCA has taken the lead in working with Illinois business, science, education and labor communities to promote technology development in and throughout our state.

Therefore, I am pleased to have this opportunity to testify before the subcommittee about Illinois' efforts, the programs we have developed, and the need to foster greater cooperation between our state, our Midwestern neighbors, and the Federal Government.

Illinois is a major force in high technology. Our state ranks third in the nation in total number of high technology jobs, with nearly 150,000 scientists and engineers as well as a solid pool of skilled technicians and production workers.

Madam Chairman, our pool of skilled labor is illustrated by the fact that just this week, recruiters from General Motors have been in this community recruiting workers for the Springhill, Tennessee, Saturn Plant.

Illinois companies are among the national leaders in computer hardware and software, modems, data communications equipment, micro-electronics, telecommunications, medical electronics, and pharmaceuticals.

The site of five federal laboratories, including, in addition to Argonne, such leaders as Fermi National Accelerator Laboratory, and the U.S.D.A. Northern Regional Research Center. Illinois is fertile ground for development of new ideas and technologies.

Recognizing the importance of technology development, Illinois has developed a three-part strategy for promoting technology innovation. One, to transform Illinois' scientific and technological resources, our comparative advantages as compared to other states, and to competitive advantages for Illinois companies.

Two, to enhance our core industries with transfer and application technology, and, three, to nurture new commercial opportunities by fostering research and development.

Let us look at how Illinois pursues these strategies. In 1985, Illinois recognized that we must focus the expertise of the best minds in our state on current problems and opportunities that promise commercial potential. To do so, we formed the Network of Technology Commercialization Centers throughout the state.

Today, there are thirteen TCCs in Illinois, located at eleven universities and two federal laboratories, operating with an annual budget between $3 million and $4 million. TCCs link technologies with researchers at such facilities as the National Center for Super Computing Applications at the University of Illinois, the Materials Technology Center at the Southern Illinois University, and the

Basic Industry Research Institute at Northwestern University, with commercial opportunities.

This linkage is very important to our strategy of using research and development to nurture new commercial opportunities. Through the TCCs, entrepreneurs may conduct feasibility studies, develop prototypes, test new products, and find Illinois firms to produce and sell their inventions.

T.C.C.s also help entrepreneurs develop their own marketing skills and access financial help. The TCCs are linked to the impressive network of services offered through DCCA's innovation small business assistance bureau, a network which includes fifty-three small business development centers, seventeen procurement assistance centers, to help firms win government contracts, and seventeen small business incubators.

This means full service assistance, assistance which can help an inventor develop a prototype, secure financing for production, and even locate production and office facilities when the idea is brought to the marketplace.

Funding new ideas is always crucial, and Illinois has developed special programs to meet these needs. The business innovation fund, commonly known as BIF, provides financing for projects which may not otherwise attract traditional lenders or venture capitalists.

The program provides financial aid to businesses, using university assistance to advance technology, create new products, or improve manufacturing processes.

Under BIF, Illinois businesses may qualify for up to a $100,000 in financial assistance for projects matched with private resources. A royalty payment agreement reimburses the state when the product is developed and sold in the marketplace.

Another important tool is our equity investment fund, which provides equity financing to companies having significant potential for job creation. Typical applicants are economically and technically viable firms with products or services capable of being commercialized within two years.

Applicants must provide two-thirds of the total project costs from other sources and may use only new outlays and investments to match these EIF resources.

E.I.F. can provide up to one-third of anticipated project costs, up to $250,000, with funding used for such costs as purchase of real estate and machinery, research and development, and working capital.

An excellent example of both BIF and EIF at work is Cell Analysis Systems, Inc. The firm received a $100,000 BIF and a $250,000 EIF in June 1986. In just two years, Cell Analysis Systems repaid the $150,000 on our $100,000 investment, the BIF investment, not a bad return.

In addition, the company's financials currently indicate earnings for last year of $500,000, implying that our equity position is conservatively worth $351,000. A forty percent return to the taxpayer which we expect to continue to grow.

Our technology grants are also an important facet in our effort to help existing industries benefit from technology advancements.

These grants enable the state to match other public and private funds to adapt new technology for basic and mature industries.

A project conducted by the Basic Industries Research Laboratory, known as BIRL, at Northwestern University, with the assistance of a $50,000 challenge grant, offers a glimpse of this program's usefulness.

For many years, the electro-plating industry has faced spiraling costs because of the difficulty and expense posed by the disposal of hazardous wastes generated in the electro-plating process. A process known as electro-winning was developed several years ago to filter and recycle these wastes, but the shear number of filters needed made the process cost prohibitive.

B.I.R.L., working with Castle Metal Finishing Company of Schiller Park, and a consortium of Chicago Metal Finishers Institute members, developed a new filter which helps recycle waste materials cost effectively.

Governor Thompson believes, that is Jim Thompson, expansion of technology challenge grants is essential to Illinois' growth as a high-technology leader. In his recent State of the State Address, the Governor proposed creation of a new $20 million challenge fund, which could be used to leverage private and federal research and development dollars for research performed in Illinois at Illinois University and companies by Illinois workers.

The funds would be used to attract private and federal investment in areas where Illinois has scientific and technological strength, such as bio-medical research, electronics, telecommunications, materials research, and basic research in physics, biology, and chemistry.

The Governor's new science advisor, Nobel Prize-winning scientist Dr. Leon Lederman, will work with DCCA, the Board of Higher Education, and the Coalition of Education, business and labor leaders, to identify projects which would meet the objectives of the challenge grant program.

Dr. Lederman's efforts will also be complemented by other new federal programs proposed by Governor Thompson. A $10 million program would help DCCA improve Illinois' productivity and competitiveness by directly assisting companies seeking technology improvements and solutions in operations.

Government funding, however, is limited. It will take passage of legislation increasing Illinois' cigarette tax to provide the revenues needed to implement these new proposals. This is why in Illinois we consider the development of special technology partnerships, a consortia formed around specific technologies or industries, so important.

The Illinois Super Computer Applications Partnership is an example. This partnership, which includes among its members the University of Chicago, Argonne, the Illinois Manufacturers Association, the American Founders Society, IBM, Cray, Control Data, Amdahl and TMA, provides awareness, training and applications of super computing technologies, receiving funding from the Department of Energy, State of Illinois, and the private sector.

Another example is the Illinois Super Conductivity Coordination Council, which coordinates applied energy-related commercial re-

search with the basic research being conducted in high-temperature super-conducting technologies.

The Council's activities were instrumental in Illinois' successful effort to land the $25 million from the National Science Foundation for a basic research center at the University of Illinois and the University of Chicago.

Public and private partnerships were particularly important in Illinois' effort to win the Super Conducting Super Collider. Although we lost the project, we gained a wealth of knowledge in the process.

We learned that technological development is valuable, not just for its own sake, but because it helps promote economic development. We learned that science and math education are essential to our children's futures, and we learned that the public and private sectors can work effectively toward a common goal.

Governor Thompson has challenged Illinois to continue these partnerships with the mission of creating more jobs at less cost at a faster pace than would have been created by the SSC. We are determined to meet this challenge.

How can we accomplish this mission? By utilizing our current resources to the maximum benefit and by developing new initiatives to address our state's technological needs, three areas, in particular, are being targeted for new initiatives.

A manufacturing technology service, modeled after Michigan's modernization service, and the Federal Agricultural Extension Service, which would further deploy new technologies into older businesses. A retooling capital fund to further help businesses make capital improvements and investments in new technologies which enhance their competitiveness and productivity, and a small business innovation research match grant to assist SBIR applicants in preparing proposals to further market and promote SBIR grants and to support SBIR recipients and further commercialization after a Phase 2 grant.

Illinois has also continued to build upon its successful partnerships with federal research and development mechanisms. Our special relationships with both Fermi Lab and Argonne demonstrate this partnership.

Both facilities house technology commercialization centers mentioned earlier. Both receive substantial state funding for technology transfer projects. The siting of the advanced proton source at Argonne and Illinois' massive effort to win the SSC for Fermi Lab were both undertaken with a firm commitment from Illinois.

The state has also been an active partner in the effort to win National Science Foundation funding for a new facility to be built at Northwestern University for research into advanced cement-based materials and is supporting IIT Research Institute's efforts to renovate gear manufacturer for the Department of Defense.

We recognize that Illinois does not stand alone. We operate in a global economy. This competitive environment requires that Illinois expand its partnership with both the Federal Government and its Great Lakes neighbors. An important step in this exchange was taken in 1987 when the Council of Great Lakes Governors established a Task Force on Research and Development.

The Task Force was one of seven charged with preparing an interstate agreement to strengthen the economic competitiveness of the region. Among the initiatives developed by the Task Force are efforts to undertake a joint marketing campaign to promote the research capabilities of the region and creation of the Great Lakes Research Network to collectively pursue a federal research agenda geared toward the region's strengths.

I believe Illinois and its Midwestern neighbors have taken aggressive strides toward enhancing the region's strength as a leader in technology development. Yet, despite enormous increases in federal funding for research and development, our region continues to receive less than its fair share.

How can Congress set a federal technology agenda which recognizes the efforts, contributions and accomplishments of Illinois and the Midwest? Three suggestions come to mind.

First, we need national coordination of state and federal efforts in support of basic science, applied research and technology transfer.

Second, we need federal incentives, such as an expanded small business innovation research program, which can encourage collaboration between small businesses and national laboratories, leading to commercialization of new technologies.

And, third, we need continued coordination of federal research programs, such as the Hollings Center, with our local and state economic development efforts.

Madam Chairman, members of the subcommittee, Illinois and its Great Lakes neighbors have the talent, the will, and the incentive to take the nation's future economic development competitiveness. Now, we need federal commitment to our region and its goals.

Thank you for this opportunity to address the subcommittee.

[The prepared statement of Mr. Hedges follows:]

TESTIMONY BY JAY R. HEDGES
Director, Illinois Dept. of Commerce and Community Affairs
BEFORE THE HOUSE SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
Friday, February 10, 1989 - Argonne, Illinois

Thank you, Chairman Lloyd and distinguished members of the Subcommittee. My name is Jay Hedges, and I am the Director of the Illinois Department of Commerce and Community Affairs, or DCCA. As Illinois' chief economic development agency, DCCA has taken the lead in working with Illinois' business, science, education and labor community to promote technology development in our State. Therefore, I am pleased to have this opportunity to testify before the Subcommittee about Illinois' efforts, the programs we have developed, and the need to foster greater cooperation between our State, our Midwestern neighbors, and the federal government.

Illinois is a major force in high technology. Our State ranks third in the nation in the total number of high technology jobs, with nearly 150,000 scientists and engineers as well as a solid pool of skilled technicians and production workers. Illinois companies are among the national leaders in computer hardware and software, modems, data communications equipment, microelectronics, telecommunications, medical electronics and pharmaceuticals. The site of five federal laboratories, including, in addition to Argonne, such leaders as Fermi National Accelerator Laboratory and the U.S.D.A. Northern Regional Research Center, Illinois is fertile ground for development of new ideas and technologies.

AD 1

Recognizing the importance of technology development, Illinois has developed a three-part strategy for promoting technological innovation: one, to transform Illinois' scientific and technological resources -- our comparative advantages (as compared to other states) -- into competitive advantages for Illinois companies; two, to enhance our core industries with transfer and application technology; and three, to nurture new commercial opportunities by fostering research and development.

Let's look at how Illinois pursues these strategies.

In 1985, Illinois recognized that we must focus the expertise of the best minds in our State on current problems and opportunities that promise commercial potential. To do so, we formed a network of Technology Commercialization Centers (TCCs) throughout the State.

Today, there are 13 TCCs in Illinois, located at 11 universities and two federal laboratories. Operating with an annual budget between $3 million and $4 million, TCCs link technologists with researchers at such facilities as the National Center for Supercomputing Applications at the University of Illinois; the Materials Technology Center at Southern Illinois University; and the Basic Industry Research Institute at Northwestern University, with commercial opportunities.

This linkage is very important to our strategy of using research and development to nurture new commercial opportunities. Through the TCCs, entrepreneurs may conduct feasibility studies, develop prototypes, test new products, find Illinois firms to produce and sell their inventions. TCCs also help entrepreneurs develop their own marketing skills and access financial help.

AD 2

The TCCs are linked to the impressive network of services offered through DCCA's innovative Small Business Assistance Bureau -- a network which includes 53 Small Business Development Centers, 17 Procurement Assistance Centers to help firms win government contracts, and 17 Small Business Incubators. This means full-service assistance -- assistance which can help an inventor develop a prototype, secure financing for production, and even locate production and office facilities when the idea is brought to the marketplace.

Funding new ideas is always crucial, and Illinois has developed specialized programs to meet this need. The Business Innovation Fund (BIF) provides financing for projects which may not otherwise attract traditional lenders or venture capitalists. The program provides financial aid to businesses using a university's assistance to advance technology, create new products or improve manufacturing processes.

Under BIF, Illinois businesses may qualify for up to $100,000 in financial assistance for projects matched with private resources. A royalty repayment agreement reimburses the State when the product is developed and sold in the marketplace.

Another important tool is our Equity Investment Fund (EIF), which provides equity financing to companies having significant potential for job creation. Typical applicants are economically and technically viable firms with products or services capable of being commercialized within two years. Applicants must provide two-thirds of the total project cost from other sources, and may use only new outlays and investments to match the EIF resources.

AD 3

EIF can provide up to one-third of anticipated project costs, up to $250,000, with funding used for such costs as purchase of real estate and machinery, research and development and working capital.

An excellent example of both BIF and EIF at work is Cell Analysis Systems, Inc. The firm received a $100,000 BIF and a $250,000 EIF in June, 1986. In just two years, Cell Analysis Systems repaid $150,000 on our $100,000 BIF investment -- not a bad return! In addition, the company's financials currently indicate earnings for last year of $500,000, implying that our equity position is conservatively worth $351,000 -- a 40 percent return which we expect to continue to grow.

Our Technology Challenge Grants are also an important facet in our effort to help existing industries benefit from technology advancements. These grants enable the State to match other public and private funds to adapt new technologies to basic and mature industries.

A project conducted by the Basic Industries Research Laboratory (BIRL) at Northwestern University, with the assistance of a $50,000 Challenge Grant, offers a glimpse at this program's usefulness. For many years the electroplating industry has faced spiraling costs because of the difficulty and expense posed by disposal of hazardous waste generated in the electroplating process. A process, known as "electrowinning" was developed several years ago to filter and recycle these wastes, but the sheer number of filters needed made the process cost-prohibitive. BIRL, working with Castle Metal Finishing Company of Schiller Park, and a consortium of Chicago Metal Finishers Institute members, developed a new filter which helps recycle waste metals cost-effectively.

AD 4

Governor Thompson believes expansion of technology challenge grants is essential to Illinois' growth as a high-tech leader. In his recent State of the State address, the Governor proposed creation of a new, $20 million Challenge Fund, which could be used to leverage private and federal research and development dollars for research performed in Illinois, at Illinois universities and companies, by Illinois workers. The funds would be used to attract private and federal investment in areas where Illinois has scientific and technological strength, such as biomedical research, electronics, telecommunications, materials research, and basic research in physics, biology and chemistry.

The Governor's new Science Advisor, Nobel Prize-winning scientist Dr. Leon Lederman, would work with DCCA, the Board of Higher Education, and a coalition of education, business and labor leaders to identify projects which would meet the objectives of the Challenge Grant program.

Dr. Lederman's efforts would be complemented by another new program proposed by Governor Thompson. That $10 million program would help DCCA improve Illinois' productivity and competitiveness by directly assisting companies seeking technology improvements and solutions in their operations.

Government funding, however, is limited. It will take passage of legislation increasing Illinois' cigarette tax to provide the revenues needed to implement these two proposals. This is why, in Illinois, we consider development of special "technology partnerships" -- consortia formed around specific technologies or industries -- so important.

AD 5

The Illinois Supercomputer Applications Partnership is an example. This partnership, which includes among its members the University of Chicago, Argonne, the Illinois Manufacturers Association, the American Foundry Society, IBM, Cray, Control Data, Amdahl and TMA, provides awareness, training and applications of supercomputing technologies, receiving funding from the Department of Energy, the State of Illinois, and the private sector.

Another example is the Illinois Superconductivity Coordination Council, which coordinates applied, energy-related, commercial research with the basic research being conducted in high-temperature superconducting technologies. The council's activities were instrumental in Illinois' successful effort to land $25 million from the National Science Foundation for a basic research center at the University of Illinois and University of Chicago.

Public/private partnerships were particularly important in Illinois' effort to win the Superconducting Super Collider. Although we lost the project, we gained a wealth of knowledge in the process. We learned that technological development is valuable, not just for its own sake, but because it helps promote economic development. We learned that science and math education are essential to our children's futures. And we learned that the public and private sectors can work effectively together toward a common goal. Governor Thompson has challenged Illinois to continue these partnerships, with the mission of creating more jobs, at less cost, at a faster pace, than would have been created by the SSC. We are determined to meet his challenge.

AD 6

How can we accomplish this mission? By utilizing our current resources to their maximum benefit, and by developing new initiatives to address our State's technology needs. Three areas, in particular, are being targeted for new initiatives: a Manufacturing Technology Service, modeled after Michigan's Modernization Service and the federal agriculture extension service, which would further help deploy new technologies into older businesses; a retooling capital fund to further help businesses make capital investments in new technologies which enhance their competitiveness and productivity; and a Small Business Innovative Research match grant to assist SBIR applicants in preparing proposals, to further market and promote SBIR grants, and to support SBIR recipients in further commercialization after a Phase II grant.

Illinois must also continue to build upon its successful partnership with federal research and development mechanisms. Our special relationships with both Fermilab and Argonne demonstrate this partnership.

Both facilities house Technology Commercialization Centers. Both receive substantial State funding for technology transfer projects. The siting of the Advanced Photon Source at Argonne, and Illinois' massive effort to win the SSC for Fermilab were both undertaken with firm commitment from Illinois.

The State has also been an active partner in the effort to win National Science Foundation funding for a new facility, to be built at Northwestern University, for research into advanced cement-based materials, and is supporting IIT Research Institute's efforts to renovate gear manufacture for the Department of Defense.

AD 7

We recognize that Illinois does not stand alone -- we operate in a global economy. This competitive environment requires that Illinois expand its partnership with both the federal government and its Great Lakes neighbors.

An important step in this exchange was taken in 1987, when the Council of Great Lakes Governors established a task force on research and development. The task force is one of seven charged with preparing an interstate agreement to strengthen the economic competitiveness of the region. Among the initiatives developed by the task force are efforts to undertake a joint marketing campaign to promote the research capabilities of the region, and creation of a Great Lakes Research Network to collectively pursue a federal research agenda geared toward the region's strengths.

I believe Illinois and its midwestern neighbors have taken aggressive strides toward enhancing the region's strength as a leader in technology development. Yet, despite enormous increases in federal funding for research and development, our region continues to receive less than its fair share.

How can Congress set a federal technology agenda which recognizes the efforts, contributions and accomplishments of Illinois and the midwest? Three suggestions come to mind.

First, we need national coordination of State and federal efforts in support of basic science, applied research and technology transfer.

Second, we need federal incentives, such as an expanded Small Business Innovation Research program, which can encourage collaboration between small businesses and national laboratories, leading to commercialization of new technologies.

AD 8

And third, we need continued coordination of federal research programs, such as the Hollings centers, with our local and State economic development efforts.

Madam Chairman, members of the Subcommittee, Illinois and its Great Lakes neighbors have the talent, the will and the incentive to shape the nation's future economic development competitiveness. Now, we need federal commitment to our region and its goals.

Thank you for this opportunity to address the Subcommittee.

###

Mrs. LLOYD. Thank you very much for your very enlightening testimony. Both of you are excellent witnesses.

Is Mr. Knuepfer here?

[No response.]

Mrs. LLOYD. If not, well, maybe he can join our next panel, because we certainly want to hear from him, also.

I think that maybe we are all well-served as the President gave us his budget message last night to point out the situation we are all very aware of, that certainly we want to provide better living conditions for our elderly, have better education opportunities, better housing, especially for our homeless, better energy programs to address the needs of our country. And clean up our environment.

But to do all these things, we know that we have to create new wealth for our country, and we are going to create new wealth by working together, not just regional entities, but working together and to address our needs in the global market by working together throughout our great land, to make the most of our technology development, to work together to market them, to aggressively take what we have in our laboratories and our universities to the marketplace, thereby increasing the wealth of our country through the good things that we want to do not only for the people of our land, but to create a better world for all mankind.

I was very intrigued by your partnership that you have worked, Mr. Hedges, to really get out and sell the technology that you are developing. I am certainly going to take the testimony back to Tennessee and say, look, this is what they are doing in other parts of the country.

What problems do you have in encouraging the cooperation between the university and the private sector and your laboratories? What are your major problems?

Mr. HEDGES. I would be less than candid if I did not say that probably in the early days, before the SSC initiative for Illinois or Fermi Lab, it was oftentimes difficult to track the interests of the private sector.

Oftentimes, we found corporate board rooms to be most interested in their own parochial interests rather than the interests of the industry as a whole.

More and more, that has become less of a problem. In Illinois at least, the SSC for Fermi Lab Committee, which was a private sector organization, pulled together the people from the board rooms that mattered, that counted, made the commitment to be there in person themselves and spend the time and their corporate resources to contribute to the effort.

It seems apparent that when the corporate dollars are in the pot as a matched public dollar, there is a stronger commitment from the private sector, and we found that to be very important.

The upcoming initiative that the Governor proposes in the State of the State speech will be predicated on that commitment, the time and dollar resources from the private sector.

I think that probably has been our significant largest issue. Aside from that is the state funding that is often needed to access federal research dollars. Oftentimes, we have projects that come to us from universities that do not have funds in their budget for the

local match requirements. They come to the State of Illinois, our Department of Commerce, looking for those matches, and we have not had uncommitted pools of dollars available.

Proposed in this coming budget year, we will have a pool of $30 million available for those purposes. So, we think we will be able to achieve a greater return on our federal dollars. I think those are two areas that we focused on.

Mrs. LLOYD. Well, Mr. Mauer?

Mr. MAUER. If I could add to that, and if I could be a bit philosophical,——

Mrs. LLOYD. You may.

Mr. MAUER [continuing]. I have a sense that we have had it so good for so long that we somewhere along the road have forgotten some of the very essential ingredients that were really necessary to the formation of the process we are talking about.

Yes, as Jay mentioned, I think we in business, frankly, have been, oh, you could say, somewhat or a lot remiss in maybe that 0area of developing linkages and recognizing the process out of which ideas and technology and research and entrepreneurial behavior really had their genesis and the payoff that is part of that process.

Likewise, in our other institutions, I think, we have also forgotten the process, and that means that, yes, in our state houses, and, yes, in our Congress and in our Administration, and, yes, in our educational arena, it just seems to me we have forgotten for so long how critical the linkages are in the inter-dependency that is absolutely critical for, as you addressed, the wealth creation and the job creation to really take place, and the outfall of much of that process is the standard of living and the good life that we have somewhat become accustomed to enjoying.

So, it seems to me we see a rather rapid reawakening, if you will, in these linkages. We are working closer with our university research and technology base. We are trying to accelerate these linkages that are extremely critical, and when you take a look at the dollars that we put into education today and the inattention historically that has been given to that process by the private sector and public sector, and how we are all rather scrambling today to redevelop those linkages and those needed linkages, to transfer technology from basic to applied and work in concert with each other.

Likewise, I think both public and private policy needs to continue to accelerate that mode, and that means we need to remove some of the impediments that discourage that process and put in its place some of those encouraging or incentive factors that help this process to accelerate.

Mrs. LLOYD. Well, obviously, we are here because we want to make the Federal Government work better on the local level, on the state level, to enhance our nation's wealth, but I think at the same time that we would all do well if we would look at the Japanese example and see that, yes, the Government can work with private industry. The Government can work better with our institutions of higher learning, and realize that if we do not work together, if we cannot reach cooperation, that we want to be our best and certainly on a collision course, then we are not going to reach our

goals, and I extend this message to industry as well as to Washington.

I think it is essential, but, thank you very much.

Mr. Fawell?

Mr. FAWELL. I have read an article in the last couple of days, and a little knowledge is a dangerous thing, I realize, but it was a conversation between a Ralph Bomerie, Senior Vice President for Science and Technology at IBM, and Harold Shapiro, President of Princeton University, and as they talked about transfer of technology and certainly what the State of Illinois is vitally involved in and what you have referred to, Mr. Mauer, their view was that try as you might at the local and the state and the federal level and academia and cooperative programs, that the biggest obstacle perhaps is private business itself, which, as Mr. Bomerie, I hope I am pronouncing that name correctly, pointed out with IBM, he said, "We have problems even having the R&D facilities at IBM communicate very well with the manufacturing and the development part of IBM."

This basic, as Madam Chairman has pointed out, lack of cooperation that is somehow an American trait, but is not a Japanese trait, for instance, where there is culturally and innately more of a cooperation that takes place.

We produce with basic research all the Nobel laureates and the breakthroughs, and then, increasingly, the rest of the world has companies out there that are very, very able to assimilate everything we produce in our breakthroughs, and these two gentlemen came down very hard and said that it is a very difficult thing to communicate with business.

Would you like—do you find that you are—I think, Mr. Hedges, you indicated that that was improving, you felt, but that these gentlemen said that we have got a lot more to do to convince business that if you do not have the advanced technologies in producing and you are not going to look as —you are not going to look like a technical giant in the world.

Mr. HEDGES. Right. I would like to think, frankly, that the states have a strong role to play, but, at the same time, I think we should all recognize that the state government or even the Federal Government, for that matter, is not going to convince the Chrysler Corporation or Caterpillar Corporation that they should begin investing in the technology that will go into their factory eight to ten years down the road.

I think those are initiatives that only corporate board rooms and corporate leaders can really pull together themselves.

For example, in the early seventies, when Caterpillar was slowly falling into the trap of being behind the times and research and development and technology application in their industry, just about when their industries were coming into very difficult times, the Governor of Illinois at the time and various leaders around the country were not saying, Caterpillar, you must retool, you must be doing R&D.

I think that our public sector has the time, the resources and the commitment and the responsibility to seek out those strategies ahead of time, in many cases, but has to be in partnership with the corporations that will really be doing the work.

On the other hand, when it comes to the smaller and medium sized companies, they do not have the ability to do a lot of this research on their own. They do not have the time to stop production one day so that the plant manager can go to McCormick Place, to the Machine Tool Show, to look at the most advanced technology available to the marketplace.

We need to be out there not teaching that man how to retool his plant necessarily, but how to convince him to get out of the plant for a couple of days, go to McCormick Place, go to the other places where the technology is on display, find the one that is appropriate for his purpose, maybe fund some of the research and studies that have to go into that early stage, and then encourage him and maybe help him finance funding of that application.

We talked a lot about, and we will hear a lot from people more qualified than I today, about the research that is going on in the laboratory, places like where we are today.

At the same time, we have a lot of technology on the shelf that are not in the marketplace, that are not in the industries of Illinois and the Midwest, that should be. They could improve the quality and efficiency of our production lines, and I think the state has a responsibility to take that message to the small manufacturer, working with, for example, the Illinois Manufacturers Association, and try and get those people to look at the technologies available to their industries and help them, encourage them, to put them in place so that we can become more competitive.

So, I do not disagree that business is certainly the critical factor, but I think there is a strong role in that our governments can affect the process, plus or minus ten percent, if we are real good or real bad.

Mr. MAUER. Let me approach it from a little different perspective that may be the good news/bad news syndrome.

The good news is that I sense and see, frankly, that there is good improvement taking place in that area, that we have recognized the divergence of interests involved in this process between academia and various public sector bodies and the private sector, and that maybe the going-it-alone is not serving us near as well as we had thought in the past.

But because of a lot of ingredients that get mixed in that process, just one of them being capital and the other being time and obviously the disciplines of science that all get immersed in this process, that the immensity of some of these initiatives get extremely expensive and time costly.

The bad news is that we need to continue to remove the impediments that have provided disincentives for this process to work much more efficiently and effectively.

It seems to me that not all but certainly some of our public universities in their governance process have an immense difficulty of dealing with moving technology, okay, from that basic to that applied and private sector mode, and some of the incentives get to be very subtle incentives, such as how do professors themselves get involved maybe in some partnership in the private sector with their idea and whatever it may be.

So, it seems to me that as we look at the governance process within our university and technology base, that we maybe need to

unwrap or remove disincentives and encourage more of this positive behavior or needed activity to take place.

I suspect we could take a look at virtually all levels of government, state and federal, predominantly and take a look at the various incentives and disincentives that are present in this process, and one of them being capital. Another one being what I would call Wall Street Pac Man today, a rather common term of how we are driving incentives of management to relatively short horizons, and I have a deep suspicion that, frankly, that is not serving us well at all.

How can one reasonably plan for the longevity, the research and the development and the technology that needs to go on today, particularly in light of our competing nations today and how they deal with that phenomenon and drive our management in this country often to extremely short horizons and incentives in the system?

So, it seems to me we again have a good news/bad news presence here, and we need to take a much closer look at how we deal with incentives and disincentives in this process.

Mr. FAWELL. Thank you.

I am not going to take any more time. I know we have many other witnesses, but that is a theme I am going to be putting forth to those who will be testifying in reference to partnership groups that are vital and involved, like Arch, for instance, here in Illinois, and the problems they are experiencing in perhaps not being able to find businesses that are really out there looking as perhaps they should.

On the other hand, I am sure, and a business man told me this last night, I should say a science and tech person who was in the publishing business, he said that he sees business still coming back and saying, hey, we are still getting all kinds of road blocks, the patenting problems, and we just—academia does not talk our language, we do not talk their language, and, so, it all comes back to that word "cooperation" again, the ability of people to get along and to see each other's particular problems.

Over and over again, the Japanese seem to be very good at this, and we have been such individualists in this nation that we are having a tougher time acclimating to the new global environment, I guess.

Mr. MAUER. Let me share one recent example I had. I suspect we are all aware of just the great amount of interest that the Japanese have, okay, in the technology that takes place and, frankly, we know that the Japanese are avid students of most, if not all, of our technology publications to the point of virtually absorbing everything in them and cataloging the information and then dispersing that information to their industry base on a very accessible basis, whereas, likewise, we have few doing the reverse of that process, whether it is Japan or Germany or any of the other nations.

So, here is a process that works, that, again, we have been relatively sleepers at that activity, and we need to certainly accelerate that process, but as we see the Japanese come through, this experience of a Japanese making a statement to me that we are just about at the point where we will be surpassing the United States in many of the measurement devices, if you will, in capital, capital

accumulation, capital formation, and also in many of the wealth-producing areas that are used to measure economic activity, making the statement that as soon as we can develop in our culture in Japan a fervor for entrepreneurial behavior, we will surpass the United States.

I think whether that is true or a partial truth, it certainly has a ring at least to me as to what is a major enhancement or a major criteria that we still have in this country, in which we can readily continue to excel, and that is our entrepreneurial base, for we know that out of entrepreneurial behavior, and I do not necessarily mean small, middle or large sized businesses, I mean a behavioral pattern of how we deal with technology and deal with innovation and deal with capital and opportunity, that this is a national asset that we need to be much more sensitive about.

Obviously, that gets us into the role of education and how that acts or what behavioral process takes place, what encouragement in education and obviously in the private sector, and the incentives that we provide in policy.

Entrepreneurial behavior is critical and it is the leading edge that we have in the United States, and we should continue to enhance and encourage that process.

Mr. FAWELL. Thank you.

Mrs. LLOYD. Thank you very much.

Mr. Stallings?

Mr. STALLINGS. Thank you, Madam Chairman.

I just have a couple of questions for my own interests.

Mr. Hedges, how long has your office, the Illinois Department of Commerce and Community Affairs, been in existence?

Mr. HEDGES. Under that title, just about ten years. We were created by Executive Order in 1979. Prior to that, we were the Department of Economic Development, a separate Department of Training, and then a separate Department of Local Government Affairs.

In 1979, all three of those agencies were confined to one. So, we are a state agency under a new name, but really these activities in terms of high technology development are more like five to six years old.

Mr. STALLINGS. This thrust that you testified to today, has that been essentially the basic thrust since the creation of this agency?

Mr. HEDGES. No. As I said, the technology development programs we highlighted today, which, frankly, are a small part of what our total agency commitment to economic development is, probably most developed in the last five to six years.

There has never been a greater demand or a greater initiative than there is right now, evidenced by this hearing itself, by this being the major thrust of the evidence, State of the State speech. There seems to be a great awareness, even in the last twelve to fifteen months, of things that we as an agency have been trying to direct to for the last four or five years.

Mr. STALLINGS. Mr. Mauer, how about your agency? About the same?

Mr. MAUER. Well, not too different than Illinois. Relatively recent phenomenon, over the last decade or so. Our department has gone through likewise a genesis of different names. Whether it

is commerce or development, I think, is unimportant, but the kind of activity that goes on is important.

Economic development and various financial incentives have been the primary drive of our agency, and only of very recent vintage has technology and science and the encouragement and the measurement of activity in this area taken place, and I am talking about probably the last five or six years at which it has received virtually any attention whatsoever.

We should have been in it for two or three decades, and it is unfortunate that it is as recent as it is.

Mr. STALLINGS. Our state created a similar department just a year or so ago, and that is why I assumed that nationwide we are going through a rather interesting trend.

I guess the question I am getting to is, are we stumbling over each other? I mean, are you two gentlemen competing for the same businesses?

Mr. HEDGES. Absolutely. Bruno and I met a couple of times secretly.

Mr. MAUER. That is off the record.

Mr. HEDGES. We in economic development in the nation is a very competitive business. I sometimes equate it to professional sports managers. We meet periodically, but when we do meet, we brag about what we do; we do not really describe exactly how we do it. We do not describe our real strategies.

There is a lot of concern about whether or not we really create economic activity or just shift it from one state to the other. We have a state policy that Wisconsin does not always share, that we do not go recruiting companies from a lot of other states. We will encourage growth.

Mr. MAUER. You are trying to be friendly.

Mr. HEDGES. For those of you from Washington and other states, we have what is commonly known in Illinois and Wisconsin as the "border wars" going on for the last two or three years over recruitment of companies and retention of companies, that I started to say generated but I guess I should say grew into what became billboard wars where we each took out billboards to defend our companies.

But I think it is a very healthy environment, and I would like to suggest that we do create a modest amount of additional, maybe, GNP or economic activity or capital investment into industries in the nation, but, really, what we are about, what our business is, is to see that each of our states, that we in Illinois, achieve a greater piece of that investment pie than we would without our state activities.

We are really chasing after the job creation and the capital investment that will, for the most part, occur without our efforts to try and make it occur, number one, in Illinois, but, most importantly, in this country because we now compete with Canada, with Europe, and with South America, particularly with Mexico, for where those jobs will be created, which is why more and more we are trying to get together and work as consortiums for regional efforts, but it is a very competitive environment.

I think it is healthy because it shows businesses in our state and other states that we care enough about them to not only talk about

them, but to market our state for them and to spend money retaining those existing jobs.

Mr. STALLINGS. I guess the point I am getting to is at the federal level, we have to disperse relatively scarce dollars at this point.

Is this a wise investment of federal money, to support fifty state departments of commerce and industry as they go out and beat up each other for attracting businesses?

Mr. HEDGES. You are doing it to a much less extent than you used to. More and more, the shifting of the burden or the pleasure of economic development is being funded by state governments, and, I think, more and more, being shifted to local governments as we as state governments become more sophisticated in our efforts. Certainly our local governments are becoming more sophisticated.

Secretary Verity as Secretary of Commerce had an initiative to shift much of the responsibility for marketing and exporting products from the U.S. to the state offices overseas rather than from foreign commercial service offices.

There are thirty-eight states that have offices in Japan. More than that have offices some place in Europe, and they are becoming much more sophisticated than the Federal Government in marketing their own services.

So, I think, yes, there is a shifting of burden, a shifting of responsibility. We continue to need a great deal of support from the Federal Government. Job Training Partnership Act is critical to our efforts. Things like the Community Development Assistance Program, CDAP, is critical to our efforts, but we accept responsibility for not only administering the programs, but also for funding them to a greater extent.

I do not think it is wasted. I do not think that there is very much at all lost in terms of waste because of competition.

Mr. MAUER. Let me assure the committee that the border skirmishes with guns and rifles or whatever between Wisconsin and Illinois are not about to take place.

Mr. HEDGES. We did use terms like disarmament, unilateral.

Mrs. LLOYD. I am going to tell Gov. McWherter to be on the lookout for you in Tennessee.

Mr. HEDGES. That is why his chair is there.

Mr. MAUER. There certainly is a level of interstate competition present and like Jay, I am not at all comfortable with that process. In fact, I think we can take a look at it. It certainly brings a fair if not a decent amount of value to the process.

I see the states as states that are experimenting and are testing and trialing a lot of different initiatives, and I think this is an area that the Congress itself needs to be extremely sensitive to. The Congress itself, just by the shear size of the monolith and the nature in which the issues that they must deal with, cannot provide a great deal of small attention to the process, but the states themselves are great experimenters, okay, in this area of job creation, economic development, and all of the economic inflow and outflow of that process.

So, we see a diversity of activity taking place in the states, and you have got to believe that each and every state is now measuring each and every other state to see what kinds of activities and proc-

esses they are getting involved in. What kind of incentives and disincentives are really on their platter today.

And out of that process, we are all honing, if you will, the economic fervor that needs to take place. Pure and simple, I do not see the Congress as being able to deal with that, but the states, by their very dimension and their very makeup, if you will, the kinds of disciplines, the kinds of cultures involved in the diversity that is there, it just seems to me that that is one of the great beauties of this land, is that we have the ability to be a diverse people with diverse interests and abilities and opportunities, and it seems to me the states are great experimenters in this economic process.

There is much more to be gained than the small price we pay for some of the small skirmishes that may take place between a border area between two states.

Mr. STALLINGS. Let me conclude my time with an observation and then a general question that maybe both of you could respond to in just a moment.

It seems to me that the driving force behind this has been the advent of the Japanese industrial power on the international scene, and the fact that we are getting beaten internationally, that traditional economies are no longer—I mean, are still going to provide nice goods and services in communities, but on an international marketplace, obviously we need to change.

So, we sort of set up the Japanese model as the model when we are all out trying to outdo each other and maybe replicate what they are doing.

First of all, I guess my question is two part. Is that long-term? I mean, will ten years from now, we will still look at that and say, that was the right way to throw all of these dollars or perhaps—you know, the Japanese have learned their lessons from us and now we are turning around and relearning from them.

Technology transfer is a key word. It is something that is vital. It is something that is very, very necessary. We are spending an awful lot of money in that area. We are trying to do a better job. There needs to be greater cooperation. There needs to be greater cooperation between the various agencies within the state.

Is this a long-term process or will, in another decade, we find a different model and then all the states will stampede over each other to look at that model and to follow that and your offices then will reorganize and do something else?

Mr. HEDGES. I think we will certainly change our strategies as time is developed and as the game changes. I think state governments are in business of economic development to stay. You all used to come home and I am sure still do and talk about the roads and the transportation dollars that you brought to your districts, but, now, the jobs and plants that you bring to your district are equally, if not more, important in this decade, and I think that will continue to be important for a long time.

But I do not think that the specific strategies that we are dealing with will be particularly long-term, talking about ten or twenty years. I do not think that the smoke stack chasing that you see going on now to some extent will be around much longer, frankly.

I do think we are going to see greater efforts in the areas that we have talked about today and the R&D and research and development and transfer of technology, application of technology.

I think we cannot become lax like we have in the nation's business economy over the last fifteen to twenty years. I do not particularly see the Japanese as the most significant threat at this point in time.

I want to make it clear that I would not trade places with them. They have some great adjustments to make in their economy as well as their social structure in the next twenty years to adapt to the progress that has been made, but the real challenge facing us now is what is going to happen to Europe in 1992.

Will we be able to compete with the Common Market when it is unified? States are starting to focus more and more towards that, and how when they develop new practices for meat slaughtering and processing that far exceed by twenty years the technologies available in this country, and it is going to be the regulations of the Federal Government and the relaxation of those regulations that will allow U.S. industry to implement the same kind of technology development in this country.

So, I think we have to continue to look at what will make us competitive in the world marketplace. If we lose out on our exports of beef and pork to Europe because of things like trade wars or because we cannot compete with the unified Common Market or the regulation of that Common Market will allow the relaxing of regulations, I think industries in this country will demand that they be given similar kinds of opportunities in order to compete with those markets.

But, certainly, the ability of American business to compete in the worldwide economy is not dependent on my department of commerce. We nudge the process along and try and lead it occasionally and try and see that we get our share of the pie, but the strategies will be changed as the rules of the game change.

Mrs. LLOYD. We need to move along, please.

Thank you. We are moving a little slow.

Mr. Beuchner?

Mr. BEUCHNER. Mr. Hedges, you gave a very glowing example of return here on Cell Analysis System with the repayment of a $150,000 on a $100,000 EIF investment.

What is your overall experience ratio with these different grants or loans?

Mr. HEDGES. We have in that particular program, we have about——

AUDIENCE. About 5 million, about fifty investments.

Mr. HEDGES [continuing]. Fifty investments in specific companies. About half of them are what we would call performing or making payments to us, which we consider to be very good, and we have only lost about ten percent of those companies, about five of them, in terms of product failure or total close-down. These are very early stage of development companies. Prototype development. Just short of going to the marketplace, and really we allow ourselves a good five years before we anticipate any return and in often cases, a good ten years before any return like this is—this is clearly the unusual example, but a good example.

Now, in terms of overall loans and investments that we make, we have about a $120 million commercial loan portfolio. We experience about a $4 million failure rate, which is very competitive in terms of commercial banks in Illinois.

But we give what I like to refer to as the bad loans. We do not compete with banks. We take the risk that the bank will not take. We invest in the company that otherwise would not be able to borrow, at least to the extent that they borrow from us, and we only do about twenty-five percent of the total project.

So, we are real pleased with the performance of our commercial loans, and we have been in that business now for about four years.

Mr. BEUCHNER. Thank you.

That is all, Madam Chairman.

Mrs. LLOYD. Mr. Schiff?

Mr. SCHIFF. Thank you, Madam Chair.

Gentlemen, I do not mind saying that as a freshman member of Congress, the committee and subcommittee, I am quite content to listen to witnesses, such as yourself, and listen to my senior members/colleagues ask questions.

I do, however, have one question for each of you, which I admit is kind of personal in nature to me.

Mr. Hedges, I am a 1968 graduate of the University of Illinois, Chicago Circle. My degree is in political science. I suspect that when I migrated west, Illinois did not miss another politician. That there were plenty here to——

Mr. HEDGES. My degree is in political science, also.

Mr. SCHIFF. In fact, I think it is a good thing I moved because I live in Sid Yates' district and he is still there, as you well know.

However, more significantly, my older brother is a graduate from the University of Illinois at Champaign, with a bachelor's degree in physics, 1963.

He moved to Southern California shortly after getting his bachelor's degree because he wanted to work in the aerospace industry, and I heard that mentioned briefly by Congressman Fawell, because he could not find an opportunity here in the aerospace industry.

Do I gather that is changing for the positive here?

Mr. HEDGES. Well, I think Dr. Ikenberry from the University of Illinois would certainly echo your concern for the loss of graduates when they come out of our great institutions. We spend a great deal of state dollars to educate people in those areas you mentioned, better than anybody else in the world, we believe, and oftentimes they do leave the state.

There is a great effort in place to attempt to change that, but that is dependent on where the industries are. If the aerospace industry were heavily in Illinois, they would be here. In fact, it is not. But, yes, those kinds of industries that will accommodate or take the graduates from our higher institutions of learning are the targeted industries that we attempt to attract.

The fact is, Illinois is not going to become the center for aerospace research and development in the near future. So, we cannot fool ourselves.

Mr. SCHIFF. But is something happening in that direction, in your judgment?

Mr. HEDGES. The industries in the areas where we feel, number one, that opportunities for research dollars from the Federal Government are greatest, to encourage the development of the defense industry, the aerospace industry, data processing and the technology-based industries, are where we are all targeting our efforts.

We think we have the resources here to challenge and to attract the companies and persuade them that they should locate here, and we are—that is what our effort is all about.

There are some successes, but we have a long, long way to go, at least in Illinois.

Mr. SCHIFF. Thank you.

Mr. Mauer, it has been twenty years since I lived in the Midwest, and things may have changed, but is Wisconsin still the place the people of Chicago drive to to see a Bears game when it is being played at home?

Mr. MAUER. Oh, it probably is. We would encourage more of that behavior, by the way.

Mr. SCHIFF. Thank you.

Mr. MAUER. Because we are a very attractive hospitality recreation and travel center.

Mr. SCHIFF. Thank you, Madam.

Mrs. LLOYD. Thank you very much.

Mr. Hyde?

Mr. HYDE. Thank you.

Very briefly, just a few comments.

I am very impressed by the caliber of the testimony from Mr. Mauer and Mr. Hedges. Outstanding. I think both of our states, Illinois and Wisconsin, are well served.

I learned a term the other day that describes as close as you can get to warfare without having it. It is called aggressive thresholding. Both of you write that down.

One of you or both of you stressed entrepreneurial behavior. It occurred to me, I remember some years ago being shocked that we only graduated in America one Ph.D. in metallurgy or some obscure statistic, but it was a shock that we were not getting the graduates, the highly-educated people, we need for all of this competitiveness, etc.

And we are hearing constantly about the cost of the college education and it is astronomical. I wonder if the private sector in Illinois, which is a good, thriving, diverse private sector, is doing its part in terms of subsidizing scholarships for outstanding young people, and I am wondering if that could not be—if every major company ought to as part of its entrepreneurial activity sponsor a scholar or two or more to study these very important science fields and it would seem to me that the way to facilitate that would be for the universities in Illinois, for example, or Wisconsin to propose a package to industry, a course of education with a price tag on it and that they would provide the education if the company will provide the scholars, and then, provide—all of us here get the finest young men and women you would ever meet coming in to apply for the military academy. They are just so impressive, and it is so edifying to see the caliber of people we have who want that education.

But I daresay there is a similar pool out there who want—are unable to afford the caliber of education their intellect would

demand, and in the fields of science and technology and other fields, and the private sector could do a great deal and they do a great deal of philanthropic work, but sponsor some scholarships, have the University of Illinois, the University of Wisconsin, Chicago, all of the major universities propose packages perhaps that entrepreneurs could adopt and that would help the universities, help the students, and help the cause of science and technology. Just a random thought.

There are many things to be said about an intellectual property, the difficulties of protecting the inventions and the innovations that we produce, yet not inhibiting the free transfer of it, and those are esoteric, as you say, arcane properties.

Well, I am very impressed. Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much, Mr. Hyde.

We want to thank these distinguished gentlemen for being with us today, and we look forward to hearing from you in the future. Thank you.

Our second panel, we hope we would move ahead a little bit speedier with our second panel, and I would ask the second panel if they would confine their remarks to about ten minutes. It would help us a great deal.

Our second panel consists of five witnesses representing the Partnership Between the Public and Private Sector. We have heard the success stories. We are impressed with your innovative approach to getting new products and services and classroom ideas to the marketplace. We hope to learn more about your views on the role the federal labor party can take and the industry can play in this in the hopes that we can all do a better job to enhance the industrial competitiveness of this mid-America region.

Certainly, our first witness is no stranger to this committee because he certainly is one of our lead witnesses annually when we hear from our national laboratories. Certainly, we recognize your contribution not only here, but in the international community as well. We are all very proud of Dr. Alan Schriesheim.

It is also good to see Terry Montgomery, who has had a big input in some of our activities in Oak Ridge and planning our economic development, the President of the Greater Minnesota Corporation.

Dr. Stephen Gage, President of Indiana Corporation for Science and Technology.

On this other side, I see Mr. Edward Miller, President of National Center for Manufacturing Sciences, Ann Arbor, Michigan, and, last but not least, Mr. Egils Milbergs, a friend of this committee, President of the Institute of Illinois.

Gentlemen, thank you for being here.

Dr. Schriesheim, you may lead off.

STATEMENT OF DR. ALAN SCHRIESHEIM, DIRECTOR, ARGONNE NATIONAL LABORATORY

Dr. SCHRIESHEIM. Thank you, Madam Chairman, for those kind words.

Madam Chairman, members of the committee, all of us at Argonne National Laboratory are certainly honored, proud and hon-

ored that you chose the laboratory as the site of your committee hearing.

I also want to thank you for the opportunity to testify on a subject that draws generally little attention in comparison to what I believe to be its real importance, and it certainly, in my opinion, is vital that we integrate national research and development priorities with the needs of regional industry and education.

It is one of the most important ways that we can assure ourselves of a high total return, total economic return on the federal investment in R&D. Too often, that integration is largely a matter of happenstance and a matter of talk rather than action. It is sort of an optional extra-curricular activity, if you will, rather than a focused program.

Argonne has been both active and experimental in finding channels of cooperation with regional, state and local industry and education. A lot of the activity flows from our real responsibility to be a good neighbor and, frankly, an important part of our motivation is economic self-interest.

We can all get more bang for the buck when we combine the scarce financial and human resources that the flow out of the federal budget with local government, local industry and academia, local academia.

Some of the best examples come from the most important part of Argonne's current programs, the initiatives which we feel will determine the future of the laboratory. I do not have really the time to go into all of them. So, I'll just mention a few.

I have a more complete testimony, Madam Chairman, that will be part of the record.

Mrs. LLOYD. No objection. All of you that have additional testimony, without objection, it will be made a part of the record of the hearing.

Dr. SCHRIESHEIM. One of them is a high-temperature super-conductivity mentioned earlier by Jay Hedges. We have the largest publicly-funded superconductivity program in the nation. Our former president, President Reagan, designated Argonne as the nation's super-conductivity research center for applications.

We are one of the three laboratories funded to find new and better ways to transfer superconductor technology to industry. I might point out that the other two laboratories are well represented here on the panel, Oak Ridge and Los Alamos. We are equally proud of the high degree of cooperation with the state in the area of super-conductivity.

For example, one of the first meetings for industry in the nation on high-temperature superconductivity was held at Argonne in 1987, June. It was co-sponsored by the State of Illinois.

A by-product of that meeting was the creation of the Illinois Superconductivity Institute funded by the state. The Institute provided financial support for the preparation of the successful proposal that was mentioned earlier by Jay, three Illinois universities, University of Chicago, University of Illinois, Northwestern University, Argonne National Laboratory, the Science and Technology Center, sponsored by the National Science Foundation. the leveraging action of $200,000 of state funding, paid off in a $25 million grant by the National Science Foundation.

A successor organization, called the Illinois Coordinating Council, matched $300,000 in state funds with $200,000 in funds from Commonwealth Edison to foster cooperative research featuring Illinois University, the federal labs and industry.

This summer, the state will fund a superconductivity institute at Argonne for Illinois high school science teachers to upgrade their knowledge and laboratory skills. The state is also expected to participate in the establishment in the very near future of a commercial spin-off, a fairly significant commercial spin-off, based on Argonne's super-conductor research, will be physically located near the laboratory.

In addition, we have organized an industry-funded superconductivity affiliates program to keep companies up-to-date on super-conducting happenings, if you will, superconducting research, and eight of the fourteen superconducting affiliates are located in the Midwest.

Now, I would be derelict in my duty, Madam Chairman, if I did not mention the second major Argonne initiative, the seven billion electron-volt advanced photon source. It is a $456 million accelerator designed to be constructed here.

Governor Thompson, Big Jim Thompson, that is, of Illinois has indicated that the state plans to use its bonding authority to help us build a major housing facility for the 2,000 visiting researchers who will use the advanced photon sources here and when it is operating.

The state, I should point out, has already paid half the cost of the geo-technical studies that are required for the APS site, and we will have several hundred million dollars in construction costs after the basic machine is built that will need to flow into the construction of the steam lines, and a large part of that cost, of course, will be expected to be paid by industry and universities, many of them from the Midwest.

The third major thrust of the lab is in advanced computer, super-computing, parallel computing, automated reasoning, thinking computer. Currently, we are developing a pilot program with the state, with state funding, to show how super-computing can be used by small and medium sized businesses. It is not an issue with respect to the IBMs and AT&Ts of the world, but it certainly is an issue of the assimilation of that technology by small and medium businesses.

I would also point out in the computing area that we are the recipients of a second National Science Foundation Science and Technology Center award with what you might call a transnational consortium. Rather than a Midwest consortium, this is a consortium consisting of ourselves, Los Alamos, Rice University and Cal Tech. So, regional, if you will, but regionally nationally, which is, of course, quite appropriate for a national laboratory.

The—I should point out that all three of these initiatives that I mentioned, superconductivity, the advanced photon source, and the parallel processing, are part of the Department of Energy's basic energy science program. By adding state monies, we speed the application of such basic research, such basic federally-funded research.

Now, the—we have also parlayed Argonne and the state resources with the efforts of local communities near Argonne. I might mention one. Thirty of the local communities have formed the Argonne Regional Consortium. This is a cooperative effort to foster local high-tech economic development, uses Argonne research as the primary attraction. The state has entered the partnership by providing $50,000 in seed money for studies on developing an entrepreneurial incubator that would be located near the laboratory and for marketing efforts.

Over the past 4 years, some 26 Argonne employees have started their own businesses. I think this is exactly what we and you should be proud of, this spinning out of technology that was generated at the laboratory. Over ninety percent, in fact, are located in the region and the spin-off process and other channels for technology transfer have been markedly accelerated by the creation of the Argonne University of Chicago Development Corporation, called ARCH.

It is a unique partnership between the university and the national laboratory. ARCH can take out patents, cut deals with industry faster, and more professionally than the lab could itself because ARCH is staffed with a group of individuals from out of the business community.

Now, I would like to close by just mentioning two collaborations with universities or groups of universities which effectively leverage our research budget. Perhaps the best example is the Midwest Plant Bio-Technology Consortium, which is a group of sixteen Midwestern universities, 35 agri-business corporations, and Argonne.

We called a meeting of this group, at which industrial representatives laid out major problems which could be solved by scientific research. Universities and Argonne chose those they believed had the capability to solve. A series of partnerships was formed to seek grants focused on each specific problem. Congress has appropriated $1.75 million for the construction of these programs, and a call for proposals has been issued for fiscal 1989 competition, and our intent, the intent of the lab and this group of universities and Midwest agri-businesses is to establish the Midwest as a real center for plant bio-technology.

Another university affiliation of which we are quite proud is the Midwest University Energy Consortium. This is made up of a group of twenty Midwest universities. With them, we have formed the Midwest Multi-Phase Flow Institute, which conducts research on campuses and Argonne on the characteristics of streams which combine solids, liquids, fluids and gases. It is an area of critical importance in a number of energy arenas.

The—we are the largest—we have the largest number of students in our educational program of any national laboratory. This is a program supported by the Department of Energy.

If you name it, we probably have a program in education. Predoctorals, post-doctorals, bright summer students. We are involved across the board. We are quite proud of that involvement. We bring high school science teachers in to utilize equipment that is present in the laboratory.

So, we are really a vital part of the region in education. I was quite pleased to hear the President's thrust in the education area last——

Mrs. LLOYD. Would you like to have more funding to bring more students into the area?

Dr. SCHRIESHEIM. Yes. In fact, I even have a number on that for you.

Mrs. LLOYD. I must say that Alan Schriesheim did not ask me to ask that question.

Dr. SCHRIESHEIM. For each $100,000 increment, we could add twenty-two/twenty-three more under-graduates. That is a tremendous payoff.

Well, the—we believe—I certainly believe that the Congress, the Bayh-Dole and the Stevenson-Wydler, your proposed initiative, laboratory initiative, national laboratory initiative, has gone a long way, Congress and the Department of Energy, have certainly gone a long way in recent times to improve our ability to transfer technology.

Certainly, our ability to transfer technology on a proprietary basis has made a major difference in terms of our dealings with industry.

I might close with just one example. Not too long ago, a refrigerator company located in Arizona had seen one of our inventions, a helium-dilution refrigerator, low-temperature refrigerator, and within six weeks, we were able to license that technology to the company. Without those acts and initiatives, never would have happened.

As I say, Madam Chairman, there is a more complete testimony here. I thank you for the opportunity to appear.

[The prepared statement of Dr. Schriesheim follows:]

Alan Schriesheim Testimony
Hearing of the Energy Research & Development Subcommittee
House Space, Science & Technology Committee
Argonne National Laboratory
February 10, 1989

Madam Chairman and Members of the Committee:

All of us at Argonne are honored that you chose our Laboratory as the site of this hearing. I also want to thank you for the opportunity to testify on a subject which draws relatively little attention in comparison to its importance.

In my opinion, it is vital that we integrate national research and development priorities with the needs of regional industry and education. It is one of the most important ways that we assure high total economic return on the federal investment in R and D. Too often, that integration is largely a matter of happenstance ... an optional, extracurricular activity rather than a focused program.

Argonne has been both active and experimental in finding channels of cooperation with regional, state and local industry and education. Part of our activity flows from the responsibility to be a good neighbor. And frankly, an important part of our motivation is economic self-interest. We can all get more bang for the buck when we combine the scarce financial and human resources out of the federal budget with those flowing from local government, local industry and local academia.

Some of the best examples come from the most important part of Argonne's current programs -- the initiatives which we feel will determine the future of our Laboratory.

One of them is in high-temperature superconductors. Argonne has the largest publicly funded superconductivity program in the nation. President Reagan designated Argonne as the nation's Superconductivity Research Center for applications. We are one of three laboratories funded to find new and better ways to transfer superconductor technology to industry.

But we are equally proud of the high degree of cooperation with the State in the area of superconductivity.

For example, one of the first meetings for industry in the nation on high-temperature superconductors was held at Argonne in June, 1987. It was co-sponsored by the State of Illinois.

A by-product of that meeting was the creation of the Illinois Superconductivity Institute funded by the State. The institute provided financial support for the preparation of a successful proposal by Argonne and three Illinois universities to become the only Superconductivity Science and Technology Center sponsored by the National Science Foundation. The leavening action of a $200,000 investment by the State paid off in a $25 million return from the NSF.

A successor organization called the Illinois Superconductor Coordinating Council matched $300,000 in State funds this year against $200,000 provided by Commonwealth Edison to foster cooperative research between Illinois universities, the federal labs and industry.

This summer, the State will fund a superconductivity institute at Argonne for Illinois high school science teachers to upgrade their knowledge and laboratory skills.

The State is also expected to participate in the establishment in the very near future of a commercial spinoff based on Argonne superconductor research which will be physically located near the Lab.

In addition, we have organized an industry-funded Superconductivity Affiliates program to keep companies up to date on superconductor research. Eight of the 14 corporate affiliates are from the Midwest.

A second major Argonne initiative involves the 7 billion electron volt Advanced Photon Source. It is a $456 million accelerator designated to be constructed here.

Governor Thompson of Illinois has indicated that the State plans to use its bonding power to help us build a major housing facility for the 2000 visiting researchers who will use the APS each year after it is operating. The State has already paid half the cost of the geotechnical studies needed of the APS site. Several hundred million dollars in construction for beam lines and associated experimental areas at the Advanced Photon Source are expected to be paid for by industry and universities, many of them from the Midwest.

This heavy industrial participation is a logical result of bringing in researchers from industry early in the conceptualization and planning stages of the Advanced Photon Source 5 years ago. We wanted to be sure the facility would be designed to meet their needs, as well as the requirements of scientists engaged in basic research.

A third major thrust of the Laboratory is in advanced computing -- supercomputing, parallel computing and automated reasoning, or the "thinking computer". Currently, we are developing a pilot program with State funding to show how supercomputing can be used by small- and medium-size business.

Regional industry and regional universities also are users of our Advanced Computer Research Facility, a center with 8 parallel computers. It is dedicated to broadening the knowledge and use of these machines and making their programs more "portable" -- that is, using programs of one machine on another.

I should point out that all three of the initiatives I have mentioned -- Superconductivity, the Advanced Photon Source and Advanced Computing -- are part of DOE's Basic Energy Science program. By adding state monies, we can speed the application of such basic research.

An important part of our close relationship with the State has come about because we have been designated an Illinois Technology Commercialization Center. The State supports us to help businessmen, especially from small business, take advantage of resources available to them -- financial as well as scientific.

As an example, Argonne has done extensive DOE-funded research in solar ponds which are saturated with salt. But if a pond leaks or needs to be drained, the water is devastating to the soil. The State is funding a local entrepreneur who is seeking a way that solar ponds can be made with fertilizer instead of salt, which would alleviate the toxicity problem.

We have parlayed Argonne and State resources with the efforts of local communities near Argonne. Thirty of those communities and other agencies in the immediate area of the Lab have formed the Argonne Regional Consortium. This is a cooperative effort to foster local high-tech economic development using Argonne research as a primary attraction. The State has entered this partnership by providing $50,000 in seed money for studies on developing an entrepreneurial incubator center near the Laboratory, and for marketing efforts.

97-750 0 - 89 - 3

Over the last four years, 26 Argonne employees have started their own businesses, chiefly in this region, based on discoveries or expertise generated at the Laboratory. That spinoff process and other channels for technology transfer have been improved with the creation of the Argonne-University of Chicago Development Corporation, or ARCH. It is a unique partnership between a university and a national lab. ARCH can take our patents and cut deals with industry faster and more professionally than the Lab could itself.

That is just one of many collaborations with universities or groups of universities which effectively leverage our research budget.

Perhaps the best example is the Midwest Plant Biotechnology Consortium, a group of 16 Midwestern universities, 35 agribusiness corporations and Argonne. We originally called a meeting of this group at which the industrial representatives nominated major problems which could be solved with scientific research. The universities and Argonne chose those they believed they had the capability to solve. A series of partnerships was formed to seek grants focused on each specific problem. Congress has appropriated $1.75 million for the Consortium's programs and a call for pre-proposals has been issued for the fiscal 1989 competition.

Another university affiliation of which we are proud is with the Midwest University Energy Consortium, made up of 20 major Midwestern universities. With them, Argonne has formed the Multiphase Flow Institute. It conducts research on the campuses and at Argonne on the characteristics of streams which combine solids and fluids, fluids and gases or various other combinations.

Some of Argonne's support of education is directly funded by the Department of Energy. We have the largest number of students in our educational programs -- ranging from high school level to post doctoral -- of any national laboratory. Currently, we are seeking to pioneer a "semester at Argonne" residence program for which college students will receive credit toward their degrees.

On the basis of this varied experience, there are some generalizations we can offer:

One is that we need to be experimental. Regional economic and educational needs vary widely. To meet those needs effectively, the federal government must allow the national labs flexibility and freedom to tailor programs to fit the partner institution.

Secondly, our major need -- on both the national and regional levels -- is to encourage participation by business. Entering into an agreement with a national lab involves extra effort and a learning process for any corporation. The process is apt to be especially demanding on the limited resources of small business.

At the heart of the problem is an inherent tension. On one side is the legitimate concern of federal administrators to assure that tax money be spent in conformance with regulations for the widest public good. On the other hand, the business executive has an equally legitimate concern. He or she wants a project followed through in a straight-line manner, with as few bureaucratic distractions, disruptions and delays as possible.

Because national lab people are not federal employees but are familiar with federal procedure, they are in an excellent position to help resolve that tension.

We can see encouraging signs of progress in diminishing the gap between the mentalities of local industry and federal agencies. One has been the change in DOE patent policy. It now recognizes that unless a corporation can get exclusive proprietary rights to a federal discovery, it is not likely to invest to develop that discovery into a commercial product.

My third suggestion relates to a similar adjustment of federal practice. Currently, federally funded discoveries in superconductivity enjoy a two-year protection from Freedom Of Information access. We at Argonne are using the same protection for non-superconductor research in our Work-for-Others program.

Congress should seriously consider whether this protection of data can be extended to other key areas of research. Likely candidates would be composite materials, microchips and perhaps tribology. Such action would implement congressional intent to foster American competitiveness in global markets. And I do not believe it would violate the intent of the Freedom Of Information Act which was not really designed to leak valuable technological and scientific discoveries.

Finally, the educational potential of national laboratories has hardly been tapped. We at Argonne could add 100 more under-graduate students and up to 60 more graduate students before we saturated our present facilities. Increased funding to allow universities greater access to the "in laboratory" experience at the national labs would represent a small investment. For each $100,000 increment, we could add 22 more under-graduates. It promises tremendous payoff in an area of great national and regional need -- attracting, holding and improving the quality of our science and math students.

In fact, that is at the heart of all of the partnership relationships I have discussed with you today: they offer very big payoff for the nation for relatively small investments wisely leveraged.

Thank you.

2/9/89

Mrs. LLOYD. Thank you, Dr. Schreisheim, it is always good to hear from you.

Mr. Montgomery?

STATEMENT OF TERRY MONTGOMERY, PRESIDENT, GREATER MINNESOTA CORP.

Mr. MONTGOMERY. Madam Chair, Congressman Fawell, thanks for your hospitality.

I would like to direct your attention, if I might, to the screen, and show you some pictures which will describe for you the Greater Minnesota Corporation. I will do this precisely in twelve minutes.

Greater Minnesota Corporation is, in fact, an innovative public/private partnership. The newest program of its type in America, just one year old, an innovative, as I said, public/private partnership described in a recent Chicago Tribune article as "The nation's most far-reaching plan to forge a partnership among business, government, universities and research institutes for economic growth" in our state, and we think one of the most ambitious in the country.

It is designed to use applied research to build Minnesota's long-term economy, particularly in rural areas of the state, but it is a major challenge. The world is changing fast and our traditional industries, agriculture, mining and forest products, have been hit hard by international competition.

We simply cannot compete with the low wages of the Pacific Rim, but we can, in fact, compete and we can win with technology, innovation and entrepreneurialship.

In the last 25 years, the single biggest factor in the remarkable rise in the U.S. standard of living has been the impact of science and technology. The Brookings Institution attributes 44 percent of the increase in productivity to technological innovation, and some economists are estimating now that seventy percent of America's economic future will depend on technology.

As Fortune Magazine said recently, "The power of American inventiveness from the light bulb to the laser, from the tractor to the transistor, is legend." But now the rest of the world is determined to catch up and we are in a real horse race.

As other nations, Japan, Germany, even the Soviet Union, accelerate their scientific and technical progress, American domination of science and technology is slipping. We must move ahead now as a state and as a nation to lead the way in translating technology to new products, businesses and jobs, and that is the bottom line reason for the Greater Minnesota Corporation.

It is not a state agency. It is not more government, not more bureaucracy. It is private sector-based and market-driven, a comprehensive approach linking education with entrepreneurialship, to build businesses and create jobs.

It comes, in the words of a former Minnesota Governor, Elmer Anderson, who formed the Fortune 500 company, the H.B. Full Company, at a strategic moment in the state's history and can make an enormous contribution to Minnesota's long-term quality of life.

It is what, in fact, the Japanese have been doing successfully for a generation and what a number of states in this country have initiated in recent years and what we believe America should be doing as a nation.

Minnesota is one of the best places in the country, perhaps one of the best places in the world, to launch an aggressive focused program to utilize technology for economic growth and job creation. We start with some impressive strengths. A superb public and private education system at all levels, an outstanding culture of entrepreneurialship which has formed some of the great companies in the world, a premiere work force which has become the envy of the nation, and a diverse economic base, ranging from the rich natural resources and tourism of Northern Minnesota to the incredibly productive agricultural lands of Western and Southern Minnesota to the dynamic technology, health care and service industries of the Metropolitan Twin Cities area of Minneapolis-St. Paul and the Duluth-St. Paul-Rochester corridor, and Minnesota has a strong tradition of building and supporting small independent businesses.

It is those entrepreneurs with twenty or fewer employees which are creating more than fifty percent of all new jobs in this country according to MIT researcher David Birch. In Minnesota, data from the U.S. Department of Commerce is even more dramatic. Eighty-seven percent of all businesses employ twenty or fewer people, accounting for twenty-six percent of all Minnesota workers.

In the famous Silicon Valley of California, where, when we think of the Valley, we think of Hewlett-Packard and Apple Computer and the other giants of the industry, seventy-five percent of the high-tech firms have ten or fewer employees. These businesses utilize local resources and hometown talent to create new products and services and jobs.

It is what, in fact, Edgar Johnson did when he started E.F. Johnson Company in Waseca, Minnesota, and built it into one of the best employers in that region of the state. That company located in a small rural community of 7,500 people of South Central Minnesota recently won a major contract to manufacture mobile telephones for the airlines, demonstrating that a small business in Greater Minnesota can successfully compete with state-of-the-art technology in the international marketplace.

Three hundred miles north of Waseca, Minnesota, in the town of International Falls, one mile from the Canadian border, another town of 7,500 people, United Health Care is processing insurance claims nationwide, soon to be worldwide, using the modern technology of telecommunications and employing already within one year's start-up one hundred workers who were trained at the local community college.

And who would have thought that when Earl Bockin began experimenting in his garage some 40 years ago the result would be Medtronic, the largest manufacturer of medical implants in the world today and a major Minnesota employer.

The list goes on and on. The enterprising industrious entrepreneur who gets an idea, develops a product and starts a business. The Greater Minnesota Corporation is working with our educational system to assist these entrepreneurs in researching new prod-

ucts and services and paving the path for the new products from the classroom to the marketplace.

Our goal is to make the GMC the best of its kind in America and our approach is systematic and businesslike. We have visited the best research centers in the country. We have worked with two of the top research institutes in the world, SLR International in California, Battelle Institute at Columbus, Ohio, to develop the program.

The board of directors represents the best of Minnesota, both rural and metropolitan, and three are nationally-prominent leaders, including Dr. Bruce Merrifield, who served as President Reagan's technology advisor for the past 8 years, and who has joined our staff as of February 1st as our vice president of research and development.

The Greater Minnesota Corporation will forge partnerships with the private sector, bringing together people, ideas and research, to create new products, businesses and jobs. The program is a practical five point strategy to position Minnesota competitively in a rapidly-changing world.

It is a free enterprise approach, community-based, and market-driven. Local boards will help design the programs and manage the operations. Matching funds will be required from the private sector and the communities.

Here is how the five point program works. First, business innovation centers are being set up in strategic locations around the state to help entrepreneurs and small to mid-sized businesses acquire technology, modernize their operations and introduce new product lines.

Radiating out from the business innovation centers in nearby communities are technology field offices to reach every corner of the state.

Second, working with the business innovation centers, our regional seed capital funds to finance technology projects.

These regional seed capital funds are started with a small grant from the Greater Minnesota Corporation and capitalized by funds from financial institutions, private investors, foundations and community organizations.

The third part of the program consists of technology research grants, which will be made to public and private colleges, universities and technical institutes throughout the state.

These grants must be matched by funds from private sources, from foundations and/or the Federal Government. Companies needing specific research to develop new products and services may apply for the applied research grants.

Part four is a network of advanced manufacturing technology centers around the state and strategic locations. Small businesses and industries will get low-cost expert help to modernize their plants, learn the newest techniques and implement the latest technology.

Rounding out the Greater Minnesota Corporation's plan are applied research institutes, specializing in agriculture, natural resources, super-computing, bio-technology and composite materials.

These applied research institutes will be located near our state universities and will operate private sector participation. Their

purpose is to quickly move research from the laboratory to the commercial marketplace.

Two of these institutes, the Agriculture Utilization Research Institute and the Natural Resources Research Institute, are already in place. The Natural Resources Research Institute in Duluth in the northern part of the state is conducting applied research to find new uses for minerals and forest products. Technology from the research labs will create a new generation of pollution-free industries, producing value-added products and building a stable long-term economy in Northern Minnesota.

At the same time, scientists at the Agricultural Utilization Research Institute will be discovering new uses and markets for Minnesota farm commodities. The Ag. Institute has research centers in four locations, Crookston, Morris, Marshall and Waseca, each specializing in the agricultural strengths of that part of the state.

One research project that is focusing on technology to create biodegradable plastic bags from corn starch which could use up to 500 million of bushels per corn. Nearly, in fact, the total Minnesota corn production in one year.

Consider the impact of that technology on any rural community in Minnesota or mid-America. 500 million bushels of corn from area farms, jobs for the people who manufacture and sell the plastic bags, and a bio-degradable product which is more environmentally sound at a time when our state, nation and world are becoming greatly concerned about the environment.

That is just one example. With the leadership of Congressman Vin Weber, your colleague in Congress, we have secured $200,000 in federal funds from USDA for nine utilization research projects focusing on new uses and markets for soybeans, corn, wheat and sugar beets. That $200,000, and I use this for this specific reason, was matched by the Greater Minnesota Corporation and by private sources, thereby generating some $600,000 in research funds for a leveraged effect of nearly two to one.

In addition, the National REA has teamed up with the Greater Minnesota Corporation to provide matching grants for local electric co-ops in Minnesota for economic development. Bob Bergland, who heads the NRECA, calls it a new partnership for America and says the Minnesota Power Project will serve as a model for other states throughout the country.

Interest in the Greater Minnesota Corporation is understandably strong, the momentum is building, and I think we are off to a good start. The legislature provided $30 million of start-up funding and further directed that one-half of the lottery in Minnesota be allocated to the GNP trust fund.

This combination of funding will build a $300 million endowment over the next five years and we currently have a bill before the Minnesota legislature to extend that fund to $1 billion. The money will be securely invested in a trust fund, insulated from politics and insulated from economic strings. Only the interest earnings will be expended, thereby making the Greater Minnesota Corporation a permanent source of help for Minnesota now and for future generations.

While our economy in Minnesota is generally continuing to improve, the growth is primarily in the Twin Cities and a few larger

communities around the state. Forty-six rural counties in Minnesota lost population in the last 6 years and much of rural Minnesota is still having a tough time.

At the time when the Metro area is booming with unemployment at about 3 percent, rural Minnesota is declining and we simply cannot afford to let that continue. Minnesotans recognize whether they live in Edina, Ely or Edgerton that a balanced state is a better state, that prosperous farmers, successful main street merchants, and thriving rural communities will make Minnesota a better place for all of us, rural and urban alike, and will help to preserve Minnesota's enviable quality of life.

Keep in mind that the GMC is not a quick fix, not an overnight panacea. It is, rather, an investment to generate long-term growth and prosperity for all Minnesotans, their children and grandchildren. It is, without a doubt, the most strategic economic development initiative ever launched in Minnesota and perhaps one of the most ambitious ever launched in this country.

Think of it this way: just 32 years ago, William Morris and a handful of entrepreneurs set up shop in a warehouse in Minneapolis and created Control Data Corporation. The rest is history. CDC went on to become one of Minnesota's premiere employers, employing at its peak some 60,000 people worldwide, and to help shape the development of the world's information technology industry.

If the Greater Minnesota Corporation can identify another Bill Morris or encourage the beginning of another CDC, the entire effort and investment will be worthwhile. More likely, I believe, is the prospect that the GMC will, over the years, identify and assist hundreds of entrepreneurs from International Falls to Worthington, from Deep River Falls to Winona, from the technology corridor in Minneapolis to Lower Town and St. Paul, who will launch hundreds of businesses which will help build a greater Minnesota and a more competitive America.

And with that in mind, I would recommend that the Congress seriously consider funding a major program as has already been suggested here today, a major program of matching grants to states to set up or expand programs similar to the Greater Minnesota Corporation to promote applied research and technology transfer.

You might even consider, with all due respect to the super-conductor/super-collider project, you might consider scrapping that project and diverting that money into programs in the states which we believe done at the local level where the rubber meets the road might have a more long-term beneficial impact on this country.

I would also recommend that a sustained commitment to research and development at the state and national level for America to remain competitive in the technology field in the years ahead. Public/private partnerships, such as the Greater Minnesota Corporation, are ideal vehicles to capture new ideas and commercialize new technology.

America's leadership in technology, we fully understand, is in jeopardy, but not lost. What we urgently need is a comprehensive commitment to convert our formidable assets into commercial successes.

At stake, very frankly, is the future standard of living of all Americans.

Thank you, Madam Chairman. Thanks to all of you on the panel and a special thanks to Argonne and to Egils Milbergs for your hospitality here today.

Thank you.

[The prepared statement of Mr. Montgomery follows:]

Greater Minnesota Corporation
1250 International Centre II
920 Second Avenue South
Minneapolis, Minnesota 55402

(612) 338-6666
FAX: (612) 339-5214

Terry Montgomery
Acting President and
Chief Executive Officer

Board of Directors

Howard G. Fortier
President,
Minnesota Teamsters
Joint Council #32

Dr. Donald S. Fredrickson
Former Director,
National Institutes
of Health

Harold W. Greenwood, Jr.
Chairman, President and
Chief Executive Officer,
Midwest Federal Savings
and Loan

Dr. D. Bruce Merrifield
Assistant Secretary for
Productivity, Technology
and Innovation,
U.S. Department of
Commerce

Dr. William F. Miller
President and Chief
Executive Officer
SRI International

W[illiam] C. Norris
Fo[under] and Chairman
Emeritus, Control Data
Corporation

Dale R. Olseth
President and Chief
Executive Officer,
Bio-Metric Systems, Inc.

Laurence L. Osterwise
General Manager,
IBM Corporation

Francis J. Ryan
Chairman of the Board,
Ryan Construction
Company

Elroy Webster
Chairman of the Board,
CENEX

May Ka Yee Yue
Founder and Owner,
Financial Services
Associates

STATEMENT OF

TERRY MONTGOMERY, PRESIDENT

GREATER MINNESOTA CORPORATION

BEFORE THE

U.S. HOUSE OF REPRESENTATIVES

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

ARGONNE NATIONAL LABORATORY AUDITORIUM

ARGONNE, ILLINOIS

FEBRUARY 10, 1989

Madame Chair, members of the Subcommittee, Governors and special guests, many thanks for the opportunity to discuss the Greater Minnesota Corporation -- an innovative, public-private partnership described by the Chicago Tribune as "...the nation's most far-reaching state plan to harness technology for economic development."

It's designed to use applied research to build Minnesota's long-term economy, particularly in rural areas of the state.

But it's a major challenge. The world is changing fast, and our traditional industries - agriculture, mining and forest products - have been hit hard by international competition. We can't compete with the low wages of the Pacific Rim, but we can compete - and win - with technology, innovation and entrepreneurship.

In the last 25 years, the single biggest factor in the remarkable rise in the U.S. standard of living has been the impact of science and technology. The Brookings Institution attributes 44% of the increase in productivity to technological innovation, and some economists estimate that 70 percent of America's economic future will depend on technology.

As Fortune magazine said recently, "The power of American inventiveness - from the light bulb to the laser, from the tractor to the transistor -- is legend."

But now the rest of the world is determined to catch up, and we're in a horse race. As other nations -- Japan, Germany, even the Soviet Union -- accelerate their scientific and technical progress, American domination of science and technology is slipping.

We must move ahead now, as a state and as a nation, to lead the way in translating technology to new products, businesses and jobs. That's the reason for the Greater Minnesota Corporation.

It's not a state agency, not more government and bureaucracy. It's private sector-based and market-driven -- a comprehensive approach linking education with entrepreneurship to build businesses and create jobs.

It comes -- in the words of former Governor Elmer Andersen -- at a strategic moment in the state's history and can make a major contribution to Minnesota's long-term quality of life.

It's what the Japanese have been doing successfully for a generation, what a number of states have initiated in recent years, and what America should be doing as a nation.

Minnesota is one of the best places in the country -- perhaps one of the best places in the world -- to utilize technology for economic growth and job creation. We start with some impressive strengths:

- a superb public and private education system at all levels;
- an outstanding culture of entrepreneurship which has spawned some of the great companies in the world;
- a premier workforce which has become the envy of the nation;
- and a diverse economic base ranging from the rich natural resources and tourism of northern Minnesota;
- to the incredibly productive agricultural lands of western and southern Minnesota;
- to the dynamic technology, health care and service industries of the metropolitan area, Duluth and the St. Cloud to Rochester corridor.

And Minnesota has a strong tradition of building and supporting small, independent business. It's those firms -- entrepreneurs with 20 or fewer employees -- which are creating more than 50 percent of all new jobs in this country, according to MIT researcher David Birch.

In Minnesota, data from the U.S. Commerce Department is even more dramatic: 87% of all businesses employ 20 or fewer people, accounting for 26% of all Minnesota workers.

And in the famous Silicon Valley in California, 75% of the high technology firms have 10 or fewer employees. These businesses utilize local resources and hometown talent to create new products and services and jobs.

It's what Edgar Johnson did when he started E.F. Johnson Company in Waseca and built it into one of the best employers in the region. That company, located in a small rural community of south central Minnesota, won a major contract to manufacture mobile telephones for the airlines, demonstrating that a small business in greater Minnesota can successfully compete with state-of-the-art technology in the international marketplace.

Three hundred miles north of Waseca -- in the town of International Falls -- United Healthcare is processing insurance claims nationwide using the modern technology of telecommunications and employing some 100 workers who were trained at the local community college.

And who would have thought that -- when Earl Bakken began experimenting in his garage some 40 years ago -- the result would be Medtronic, the largest manufacturer of medical implants in the world today, and a major Minnesota employer.

The list goes on and on. The enterprising, industrious entrepreneur who gets an idea, develops a product and starts a business. The Greater Minnesota Corporation is working with our educational systems to assist these entrepreneurs in researching new products and services and paving the path for new products from the classroom to the marketplace.

Our goal is to make the Greater Minnesota Corporation the best of its kind in America, and our approach is systematic and businesslike.

We have visited the best research centers in the country, and we have worked with two of the top research institutes in the world -- Stanford Research and Battelle Institute -- to develop the program.

The board of directors represents the best of Minnesota, both rural and metropolitan, and three are nationally prominent leaders, including Dr. Bruce Merrifield, who served as President Reagan's technology advisor.

The Greater Minnesota Corporation will forge partnerships with the private sector, bringing together people, ideas and research to create new products, businesses and jobs.

The program is a practical, five-point strategy to position Minnesota competitively in a rapidly-changing world. It's a free-enterprise approach, community-based and market-driven. Local boards will help design the programs and manage the operations. Matching funds will be required, from the private sector and the communities.

Here's how the five-point program works:

First, Business Innovation Centers are being set up in strategic locations around the state to help entrepreneurs and small to mid-size businesses acquire technology, modernize their operations, and introduce new product lines. Radiating out from the Business Innovation Centers in nearby communities are Technology Field Offices to reach every corner of the state.

Second, working closely with the Business Innovation Centers are Regional Seed Capital Funds to finance technology projects. These Regional Seed Capital Funds are started with a small grant from the Greater Minnesota Corporation and capitalized by funds

from financial institutions, private investors, foundations and community organizations.

The third part of the program consists of technology research grants to public and private colleges, universities and technical institutes throughout the state. These grants must be matched by funds from private sources, foundations and/or the federal government. Companies needing specific research to develop new products or services may apply for the applied research grants.

Part four is a network of Advanced Manufacturing Technology Centers around the state. Small businesses and industries will get low-cost expert help to modernize their plants, learn the newest techniques and implement the latest technologies.

Rounding out the Greater Minnesota Corporation plan are Applied Research Institutes specializing in agriculture, natural resources, supercomputing, biotechnology and composite materials. These applied research institutes will be located near state universities and will operate with private sector participation. Their purpose is to quickly move research from the laboratory to the commercial marketplace. Two of these institutes, the Agricultural Utilization Research Institute and the Natural Resources Research Institute, are already in place.

The Natural Resources Research Institute in Duluth is conducting applied research to find new uses for minerals and forest products. Technology from the research labs will create a new generation of pollution-free industries, producing value-added products and building a stable, long-term economy in northern Minnesota.

At the same time, scientists at the Agricultural Utilization Research Institute will be discovering new uses and markets for Minnesota farm commodities. The ag institute has research centers in four strategic locations -- Crookston, Morris, Marshall, and Waseca -- each specializing in the agricultural strengths of that part of the state.

One research project is focusing on technology to create biodegradable plastic bags from corn starch, which could use up to 500 million bushels of corn per year.

Consider the impact of that technology on any rural community in Minnesota. Five-hundred-million bushels of corn from the area farms, jobs for the people who manufacture and sell the plastic bags, and a biodegradable product which is more environmentally sound, at a time when our state, nation and world are becoming greatly concerned about the environment.

That's just one example.

With the leadership of Minnesota Congressman Vin Weber, we have secured $200,000 in federal funds for nine utilization research projects, focusing on new uses and markets for soybeans, corn, wheat and sugarbeets.

That $200,000, by the way, was matched by the Greater Minnesota Corporation and by private sources, thereby generating some $600,000 in research funds for a leverage effect of 2 to 1.

In addition, the National REA has teamed up with the Greater Minnesota Corporation to provide matching grants for local electric co-ops in Minnesota for economic development. Bob Bergland, head of the NRECA, calls it a new partnership for America, and says the Minnesota pilot project will serve as a model for other states throughout the country.

Interest in the GMC is strong, the momentum is building, and we're off to a good start. The legislature provided start-up funding and further directed that one-half of lottery proceeds be allocated to the GMC Trust Fund. This combination of funding could build a $300 million endowment over five years.

The money will be securely invested in a trust fund, insulated from politics and economic swings. Only the interest earnings will be expended, thereby making the Greater Minnesota Corporation a permanent source of help for rural Minnesota, now and for future generations.

While the Minnesota economy is continuing to improve, the growth is primarily in the Twin Cities and a few larger communities around the state. Forty-six rural counties lost population in the last six years, and much of rural Minnesota is still having a tough time.

At a time when the metro area is booming, rural Minnesota is declining, and we must not let that continue.

Minnesotans recognize -- whether they live in Edina, Ely or Edgerton -- that a balanced state is a better state -- that prosperous farmers, successful mainstreet merchants and thriving rural communities will make Minnesota a better place for all of us -- rural and urban alike -- and preserve Minnesota's enviable quality of life.

Keep in mind that the GMC is not a quick fix, not an overnight panacea. It's rather, an investment to generate long-term growth and prosperity for all Minnesotans and their children and grandchildren. It is -- without doubt -- the most strategic economic development initiative ever launched in Minnesota.

Think of it this way:

Just 32 years ago, William Norris and a handful of entrepreneurs set up shop in a warehouse in Minneapolis and created Control Data Corporation. The rest is history. CDC went on to become one of Minnesota's premier employers and to shape the development of the world's information technology industry.

If the Greater Minnesota Corporation can identify another Bill Norris or encourage the beginning of another Control Data, the entire effort and investment will be worthwhile.

More likely, I believe, is the prospect that the GMC will, over the years, identify and assist hundreds of entrepreneurs from International Falls to Worthington, from Thief River Falls to Winona, from the Technology Corridor in Minneapolis to Lowertown in St. Paul, who will launch hundreds of businesses which will help build a greater Minnesota and a more competitive America.

With that in mind, I would recommend that the Congress consider funding a major program of matching grants to states to set up or expand programs similar to the Greater Minnesota Corporation to promote applied research and technology transfer.

I would also recommend a sustained commitment to research and development at the state and national level for America to remain competitive in the technology field.

Public-private partnerships, such as the Greater Minnesota Corporation, are ideal vehicles to capture new ideas and commercialize new technology.

America's leadership in technology is in jeopardy but not lost. What we urgently need is a comprehensive commitment to convert our formidable assets into commercial successes. At stake is the future standard of living of all Americans.

Mrs. LLOYD. Well, thank you very much. Excellent testimony. We certainly appreciate you being with us today.

Dr. Gage, we look forward to hearing from you as well.

STATEMENT OF DR. STEPHEN J. GAGE, PRESIDENT, INDIANA CORPORATION FOR SCIENCE AND TECHNOLOGY

Dr. GAGE. Thank you, Madam Chairman, and distinguished members of the subcommittee.

I first wish to convey greetings from Governor Bayh, who wished to be here today. As you mentioned, his testimony has been submitted for the record.

He wanted me to emphasize particularly his support for the role of technological innovation and transfer in making our companies and universities more competitive in the global marketplace.

I am Stephen Gage. I am President of the Corporation for Science and Technology. and I am very pleased to appear before this subcommittee to talk about the creation and the operation of the Indiana Corporation for Science and Technology.

Along the way, I also will offer some views on how we can improve the ways our industries, universities, national laboratories and state governments work together to improve industrial competitiveness.

The Indiana Corporation for Science and Technology or CST was established during the recession of the early 1980s. Since a significant portion of Indiana's manufacturing base was directly tied to steel and automobile production, it consequently was severely impacted by the recession.

The Governor and Lieutenant Governor decided that every attempt should be made to diversify the state's manufacturing economy. Not just through company recruitment or smoke stack chasing, as it was called earlier, but also through company generation.

Thus, CST was conceived as a means of harnessing the combined powers of the public and private sectors to strengthen the state's economy through development transfer and commercial application of new technologies.

C.S.T.'s charter is to provide technological advice, counsel, business and financial counselling and financial assistance to Indiana's entrepreneurs, businesses and industries, colleges and universities, and governmental units.

To carry out this charter, CST was established as a private nonprofit corporation governed by a 25 member board of directors, selected from the executive offices of the business, government and university sectors of Indiana. The board members are appointed by the Governor.

In order to be relatively brief, I would like to submit a copy of our annual report which describes the operation in much more detail for the record, and then to continue, I would like to touch on a few of the major points.

C.S.T.'s funding is provided by the Indiana General Assembly, even though we are a not-for-profit corporation. For the past 6 years, the General Assembly has provided $10 million per year. To date, CST has invested over $50 million in over ninety projects.

The investments have been primarily four major areas. New product development in new business start-ups and emerging companies. New product development in existing companies. University research and development centers and technical support.

The allocation among these four categories is roughly one-half of new business start-ups, one-quarter in existing companies, one-sixth in university R&D centers, and most of the remainder in technical support.

The most common forms of the awards are loans to for-profit companies and grants to university centers and technical support agencies. After funding, the performance of each project is reviewed regularly by CST staff and needed technical business and financial assistance is provided "brokered" by the CST staff to the companies.

C.S.T. requires that the loans to the for-profit companies be paid back to the corporation at twice the loan principal. These pay backs in the form of royalty based on a percentage of the gross revenues from the developed products are then reinvested by CST in new projects. The intent of the pay back provision is to create in the long run a self-perpetuating investment fund to continue these activities in the state.

C.S.T. works closely with the companies receiving the loans to help arrange for the other needed sources of money. Private equity, venture capital or conventional financing to bridge the projects into the commercial arena.

C.S.T. also encourages entrepreneurial companies to seek early stage funding through the federal small business innovation research programs. Several Indiana companies which were started as a result of SBIR grants subsequently were funded by CST and now offer considerable commercial promise in the state.

As Governor Bayh indicated in his remarks, we consider the SBIR awards to be excellent investments of federal R&D funds and of critical importance to Indiana's entrepreneurs.

Because of this, the Governor has encouraged the Congress to consider increasing the percentage of federal R&D funds reserved for SBIR programs.

As the head of a state program which complements the federal SBIR programs, I would also like to encourage improved coordination between the federal SBIR program and those of us in the states trying to achieve common goals.

Such coordination has begun with, and working quite well, several of the federal agencies, but it could be improved greatly across the board.

C.S.T. has also funded five university-based R&D centers in biotechnology, opto-electric components, and in superfund activity. The purpose of these centers is to enhance the capability of our universities to conduct research that will in the long run have application in many industrial sectors across the state as well as to assist the business and industry in developing advanced technology-based products.

C.S.T. encourages the university centers to leverage state funds with both industrial and federal funds, and to establish real working relationships with both federal and industrial laboratories.

We have been very pleased with an initial round of meetings between Argonne National Laboratory personnel and Indiana's super-conductivity center. This center is a joint effort between the University of Notre Dame and Purdue University. Given the challenges that the U.S. faces in competing in this fast-moving area of super-conductivity, we hope that these discussions will ripen into a mutually-beneficial cooperative effort between Argonne and Indiana companies and universities.

To help Indiana's small and medium sized manufacturing companies survive and grow in this fierce competitive global marketplace, CST is making these companies aware of rapid technological change and is assisting them in helping to utilize these new technologies.

To provide this assistance, we are investigating the efficacy of two new inter-related industrial support programs aimed at addressing these needs. These two programs are the micro-electronics design center, which is concentrating on expanding the use of applications of specific integrated circuits or ASICS, they are called, in the products made by Indiana's manufacturers, and the manufacturing technology service, which is pro-actively helping small and medium sized companies identify, adopt and use improved automation technologies to increase their competitiveness.

As the Governor pointed out in his testimony, we are concerned that the limited manufacturing technology center programs sponsored by the National Institutes of Standards and Technology so far ignores the needs of manufacturers in Indiana and in most of the other heavily-industrialized states here in mid-America.

While we applaud the establishment of the three centers, one of which is located in Cleveland, we believe that the real challenge that NIST must face is how to structure these centers to serve the need of manufacturers across several states, not just in a local area.

It would seem to make good sense to get the design of these manufacturing technology centers right in the first place rather than having to try to broaden their scope and change their orientation years later when it becomes clear that the nation can only afford a limited number of the centers.

This could be very similar to the challenge that this subcommittee now faces in trying to broaden the national laboratories into multi-state resources after the laboratories have been running for forty years.

My brief description of CST would be incomplete if I did not indicate the critical role played by our thirteen technology committees and our two education committees.

With over 500 voluntary technical experts in companies and universities across the state serving on these committees, an extensive network has been created over the last five years which helps CST stay abreast of the technology developments most important for Indiana's future.

A critical function also played by committee members is that a number of members selected from each committee review the technical proposals that are considered by the CST, but possibly of greater importance to the Indiana companies and educational institutions represented, though, are the vital relationships which have

been established among the participants. This network of voluntary experts is the real personification of Indiana's public/private partnership in science and technology.

In his recent book, "Odyssey: Pepsi to Apple", John Sculley, the CEO of Apple Computer, says, "The best way to predict the future is to invent it." As you can tell from my description of CST's program, Indiana is a state which has taken Sculley's advice to heart and is putting technology development and transfer to work.

Thank you very much for this opportunity to address you here today.

[The prepared statement of Dr. Gage follows:]

Hearings before the

Subcommittee on Energy Research and Development

Committee on Science, Space, and Technology

U.S. House of Representatives

ARGONNE NATIONAL LABORATORY
Argonne, Illinois

Testimony of

Dr. Stephen J. Gage, President

Indiana Corporation for Science and Technology

February 10, 1989

Madame Chairperson and distinguished members of the Subcommittee:

I am pleased to appear before the subcommittee to describe the creation and operation of the Indiana Corporation for Science and Technology. I will also offer some views on how we can improve the way our industries, universities, national laboratories, and state governments can work together to improve industrial competitiveness in the United States.

The Indiana Corporation for Science and Technology (CST) was established during the recession of the early 1980's. Since a significant portion of Indiana's manufacturing base was directly tied to steel and automobile production and consequently was severely impacted by the recession, the Governor and Lt. Governor decided that every attempt should be made to diversify the state's manufacturing economy. Thus CST was conceived as a means of harnessing the combined powers of the public and private sectors to strengthen the State's economy through development, transfer, and commercial application of new technologies. The creation of CST was, of course, similar to initiatives launched in a number of the Mid-American states during that difficult period.

CST's charter is "to provide technological advice and counsel, business and financial counseling, and financial assistance to Indiana's entrepreneurs, businesses and industries, colleges and universities, and governmental units". To carry out this charter, CST was established as a private, non-profit corporation governed by a 25-member Board of Directors selected from the executive offices of the business, government, and university sectors of Indiana; the Board members are appointed by the Governor.

In order to be relatively brief in my description of the operations of CST, I would like to submit a copy of CST's Annual Report for the record.

To continue, CST's funding is provided by the Indiana General Assembly. For the past six years, the General Assembly has provided $10 million per year. To date, CST has invested over $50 million in over 90 projects. The investments have primarily been made in four major areas:

- New Product Development in New Business Startups and Emerging Companies
- New Product Line Development in Existing Companies
- University Research and Development (R&D) Centers
- Technical Support.

The allocation among these four categories [as shown in Figure A attached] is roughly one-half in New Business Startups, one-quarter in Existing Companies, one-sixth in University R&D Centers, and most of the remainder in Technical Support.

Awards are based on a rigorous four-stage evaluation of the technological and business merits of the proposals. All of the proposals from for-profit companies must include a detailed business plan. The most common forms of awards are loans to for-profit companies and grants to university centers and technical support agencies. After funding, the performance of each project is reviewed regularly by CST staff. Needed technical, business, and financial assistance is provided or brokered by CST to the companies on a timely basis.

CST requires that the loans to for-profit companies must be paid back to the Corporation at twice (2X) the loan principal. These paybacks, in the form of royalty based on a percentage of the gross revenues from the developed products, are then reinvested by CST in new projects. CST works closely with the companies to help arrange for private equity, venture capital, or conventional financing to bridge the project into commercial sales, thus highly leveraging the State-provided funds.

CST also encourages entrepreneurial companies to seek early-stage funding through the federal Small Business Innovation Research (SBIR) programs. Several Indiana companies, which were started as the result of SBIR grants, subsequently were funded by CST and now offer considerable commercial promise. As Governor Bayh indicated in his remarks, we consider the SBIR awards to be excellent investments of federal R&D funds and of critical importance to Indiana's entrepreneurs. Because of this, the Governor has encouraged the Congress to consider increasing the percentage of federal R&D funds reserved for SBIR programs. As the head of a state program which complements the federal SBIR programs, I would also like to encourage improved coordination between the federal SBIR programs and those of us in the states trying to achieve common goals. Such coordination has now begun but it could be improved greatly.

As indicated in the Annual Report, CST has funded five university-based R&D centers [identified in Figure B attached]. The original purpose of these centers was to enhance the capabilities of Indiana universities to conduct research that would, in the long term, have applications in many industrial sectors as well as to assist business, industry, and agriculture in developing advanced technology-based products.

Financial support to non-profit organizations such as university centers generally assumes the form of a grant. If any derivative commercial products or services result from the research, CST will receive payback in the form of royalties on licenses, etc. CST encourages the university centers to leverage the state funds with both industrial and federal research funds.

We have been pleased with the initial round of meetings between Argonne National Laboratory and Indiana's Superconductivity Center (which is a joint effort of Purdue University and the University of Notre Dame). Given the challenges that the U.S. faces in competing in the fast-moving area of superconductivity, we hope that these discussions ripen into mutually beneficial, cooperative efforts between Argonne and Indiana companies and universities.

To help Indiana's small and medium-sized manufacturing companies survive and grow in the fiercely competitive global marketplace, CST is making these companies aware of the rapid technological changes and is assisting them in beginning to utilize these new technologies. These technologies are affecting all operations of the companies -- from product design, analysis, and testing, to manufacturing processes, to quality assurance, to inventory control, etc. To provide this assistance, CST is investigating the efficacy of two new inter-related industrial support programs aimed at addressing these needs. Although different in approach, each is grounded in the conviction that significant competitive advantage can be gained by small and medium-sized companies if they are given timely, affordable and usable access to state-of-the-art technologies.

Indiana's two experimental technology transfer programs are the Microelectronics Center (which is concentrating on expanding the use of Application Specific Integrated Circuits) and the Manufacturing Technology Service (which is proactively helping companies to identify, adopt, and use improved automation technologies to increase their competitiveness). Further description of these two programs is given in Figure C. As the Governor pointed out, we are concerned that the limited Manufacturing Technology Center program sponsored by the National Institute of Standards and Technology so far ignores the needs of manufacturers in Indiana and in most of the other heavily industrialized states in Mid-America.

While we applaud NIST's establishment of three Centers, one of which is located in Cleveland, we believe that the real challenge that NIST must face is how to structure Centers that can serve the needs of manufacturers across several states, not just in a local area. It would seem to make good sense to get the design of the Manufacturing Technology Centers right in the first place, rather than trying to broaden their scope and change their orientation years later when it becomes clear that we as a nation can afford only a limited number of such Centers. This could turn out to be similar to the challenge that this subcommittee now faces in trying to broaden the national laboratories into regional (multi-state) resources after the laboratories have been running for forty years.

My brief description of CST would be incomplete if I did not indicate the critical role played by CST's thirteen Technology and two Education Committees. With over 500 voluntary members from across the state serving on these committees, an extensive network has been created which helps CST stay abreast of the technology developments most important for Indiana's future. A critical function the committees play is that selected members provide technical reviews of all proposals considered by CST. Committee members also provide business and technical assistance to companies seeking help from CST. Possibly of greater importance to the Indiana companies and educational institutions represented, though, are the vital relationships which have been established among the participants.

In his book Odyssey: Pepsi to Apple, John Sculley, Chairman and CEO of Apple Computer, says, "The best way to predict the future is to invent it." As you can tell from my description of CST's program, Indiana is a state which has taken Sculley's advice to heart and is putting technology development and transfer to work.

FIGURE A

CST DIVERSIFIED INVESTMENTS
FUNDS COMMITTED TO DATE
JUNE 30, 1988
$45,679,962

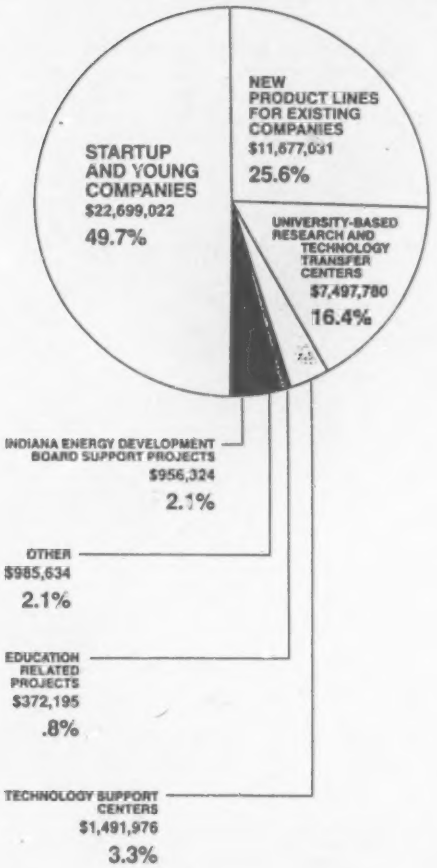

Figure B

University-Based Research and Development Centers

Applied Optics Center, Rose-Hulman Institute, Terre Haute

Agricultural Biotechnology Research Center, Purdue University, West Lafayette

Biotechnology Research Center, Indiana University, Bloomington

Optoelectronics Research Center, Purdue University, West Lafayette

Superconductivity Research Center, Purdue University, West Lafayette, and University of Notre Dame, South Bend

Figure C

CST-Sponsored Technology Transfer Programs

Indiana Microelectronics Center (in conjunction with Adaptive Microware, Inc., Fort Wayne). Assists Indiana companies in the specification, design, fabrication, and testing of Application Specific Integrated Circuits (ASIC) microchips for incorporation in the companies' products. One ASIC microchip has been produced and integrated in a commercial product. Others are under development during the current pilot phase. If the pilot is successful, a network of regional centers will be established across the State.

Indiana Manufacturing Technology Service. This program has established, in four regions of the State, service centers to proactively foster the identification, adoption, and use of improved technologies to increase the competitiveness of small and medium-sized Indiana manufacturers.

Mr. FAWELL [presiding]. Fine. Well, thank you very much, and we will move on then to Dr. Miller, if you will care to give your statement.

STATEMENT OF EDWARD A. MILLER, PRESIDENT, NATIONAL CENTER FOR MANUFACTURING SCIENCES

Mr. MILLER. Madam Chair, distinguished members of Congress, my name is Edward Miller, and I am the President of the National Center for Manufacturing Sciences.

I am pleased to be here today on behalf of NCMS to address industry's perspectives and priorities with respect to science and technology policy in the decades ahead.

I would like to talk about three issues. The creation of NCMS and the factors that were influencing our membership when it was created. The social, economic and regulatory environment and its influence on industrial consortia and science and technology, and, lastly, some recommendations on science and technology policy and strategy.

First, let me begin by saying the National Center for Manufacturing Science is not the result of any single individual, any single event, any activity, or any individual organization. Quite to the contrary.

It is the result, it is the product of a large number of individuals, a large number of organizations, including private sector, including the government, that come together in a consensus fashion when they recognized the problems that were in front of us.

The National Center for Manufacturing Sciences reflects the wisdom of Congress in recognizing the global conditions that were changing and the implementation of the national cooperative research, a change in the anti-trust laws.

It conveys the insights and the wisdom of business leaders from across the nation.

Basically, the NCMS was formed in response to a growing concern that our nation was declining in competitiveness in its manufacturing industries. After decades of watching our industries be decimated systematically by our foreign trading partners, U.S. business leaders concluded that they could no longer compete individually in the marketplace.

By the fall of 1985, we understood sufficiently the span and scope of the problems in front of us. Many of our foreign trading partners were cooperating on a national basis.

In addition to the many positive and large productivity gains that they had achieved, they were also resorting to a number of unfair trade practices. Tariffs, barriers, quotas, dumping, price fixing, in industries like consumer products, televisions, electronics, machine tools, semi-conductors, are all history.

It was against this backdrop that the U.S. manufacturing community concluded that the key to the solution was an industry-managed and industry-led effort to regain manufacturing technology superiority.

Their vision was shared by the Department of Defense and others who supported and encouraged their efforts to design a solution. Further, it was with the recognition of these decisions from

industry that President Reagan established his domestic action plan to support the restoration of the manufacturing technology industries.

In the formative stages of NCMS, our leaders could see some of the problems in front of them, but we could not see all of them. Today, I think we understand and have had an opportunity to look more, and we have seen the magnitude, the span, the scope of the cooperative efforts around the world by our foreign trading partners increasing every day.

While we understood that we had declined 30 to 35 percent in productivity, we did not understand the full implications of all of the joint industry government consortia that existed back in the early 1980s. We do today.

They are continuing. They are continuing around the world and they are broadening with more and more countries becoming involved. Whether we want to talk about Europe in 1992 and the forty some odd consortia that have been formed there that are all partnerships in cooperative efforts of government, industry and academia, whether you talk about Esprit, Eureka, Brite, or any number of other consortia, or you talk about the Pacific Rim, you talk about Japan and its ministries and its 485 industrial cartels, or you talk about Korea or Malaysia or Singapore, the story is much the same.

What is happening is that the global economy is changing, and we are transitioning from a domestic economy and that the way we do business must change with that economy.

We believe that key to the competitiveness of our industry is restoring the technological leadership that we maintain, that we must maintain, both in product and manufacturing technology.

This leads me to my second point, the environment. At NCMS, we do not think that we should attack the symptom, but, rather, the problem. We believe that the environment is part of the problem that affects industry today, and when I talk about the environment, I refer loosely to everything that affects the social, the economic, the regulatory, the trade environment that are external to our companies that cannot be affected or influenced by the executives in business. This includes trade law, tax law, product liability law, intellectual property rights law, anti-trust laws. It includes educational capabilities of the work force that are entering. It includes changing of international exchange rates on a daily or weekly basis.

Over the past two hundred years, our system of government and our system of industry has served us exceedingly well, but during that last two hundred years, we have built the greatest economy, the strongest economy in the world, the highest standard of living that is known.

Recently, that environment has begun to show signs of strain. At NCMS, we believe it is time to re-examine the environment and to consider making those changes that will carry us far into the future and restore us to a leadership role in a global economy.

We further believe that this will best be accomplished if we forge the right partnerships. That is, partnerships between governments, between industries, and between academia.

We believe each of us has an important and a central role to play, and that all of those roles are necessary if we are going to make changes in this environment.

While there may be many ways to improve our science and technology environment, at NCMS, we believe one of the key ways or one of the most important would be to have a national industrial policy. Not a de facto policy that results from inaction, and not a policy that is developed in a vacuum, but a policy that is forged with input and consensus from business leaders across the nation. A policy not for business alone, but one that is coordinated with our defense programs, our foreign policies, our social programs, our educational programs, all of them.

An industrial policy where we recognize constraints, the weaknesses and the roles best for each sector of our economy. Government to lead and manage our nation, our states, and our local economies. Academia to educate our youth and to improve the capabilities of our citizens. And industry to develop and produce the goods and services needed by our citizens and by our foreign trading partners.

An industrial policy where each sector plays a support role to the other sectors of our economy where they are playing a lead role.

Today, I think we cheat ourselves. We do not get the best out of our economy for our citizens. Although government, academia and industry talk to each other and sometimes we listen, more often than not, I think we are in adversarial roles.

This must change. It has changed with all of our foreign trading partners. I do not have a new paradyne to offer that solves all of our problems and difficulties. Rather, I offer NCMS as an example of what can and should be accomplished and suggest ways that it can be strengthened and broadened.

Earlier, I mentioned that NCMS is the result of a collective wisdom. It is a consensus by hands-on management and on member companies. At NCMS, my staff and I lead and manage. We facilitate and create the environment in which science and technology needs can be identified and undertaken.

Our members, that is, the hands-on management of our industry, analyze, prioritize and decide. This is a very important point because it is quite different than the operations in our private sector.

At NCMS, our goal is to create a science and technology pull, not a push. We do not dictate research programs that intrigue our staff. Quite to the contrary. We only start programs that our members indicate they need. As a result, they have product commercialization in mind right from the beginning.

Since we have both technology users and suppliers involved, we know how and where and what it will take to manufacture it. We know what the market is and where it exists. As a result, our members are eager to undertake the research, to share in its costs, and to support the marketplace when it is completed.

Today, our competitiveness difficulties are too large, too complex, and too diverse for any one of us to solve individually. And when I say individually, I mean all organizations, for government, for industry, or for academia.

We must work together in much the same way that NCMS and its members work together. Scientists and engineers from government, academia, and industry working side-by-side in the same facility, working together on the same projects.

Most of our foreign trading partners have overcome this barrier. Not only does it mean cooperation instead of competition, but it also means that the contributor, each party in this, must be able to achieve his or her goals.

For industry, the goal is technology transfer in product commercialization, and it has to be built in right at the beginning, independent of where the research takes place.

Now, I am delighted that you are holding these hearings at Argonne National Lab. Our nation has a wealth of resources in its federal laboratory system, including Argonne. The science and technology quality of research that has been performed in the past is second to none in the world.

We undertake some of the very best that is done anywhere. However, as I mentioned earlier, I think we cheat ourselves. We do really great research and then we try to figure out what to do with the results. We do not have a plan in mind in advance for all of the things that we pay for.

I recognize, however, that we have a wealth of knowledge, know-how and intellectual property that we have accumulated over the past decades. The Stevenson-Wydler Technology Innovation Act, the Federal Technology Transfer Act, and Executive Order 12-591, facilitating access to science and technology, are steps in the right direction to transfer that out, but they are technology-push oriented and, generally, technology-push programs have a low success rate.

I believe much of the past results from science and technology research could be useful. However, to be of commercial value, I think it must be reviewed, be analyzed, and probably be combined with other technology and a substantial investment in capital made to obtain marketable product status.

This can probably best be undertaken by private industry or industrial consortia. I think that an organization like NCMS with manufacturing technology would be interested and could help the transfer of technology out of the laboratories and the Defense Department systems in that regard.

There are other consortia that specialize in other areas.

I would like to talk about my third point, science and technology policy. My recommendation here is really very short and very simple. And that is, we have to shift our focus from mostly basic research to mostly exploratory development and applications development.

Do not misunderstand what I am saying. I believe basic research is very, very important. We would not enjoy the high standard of living in the United States that we have if it were not for the discoveries and the breakthroughs brought about by basic research.

The problem is, in our economy, it takes about twenty years for most of the benefits of a major discovery to be realized by the consumers. Somehow, we have to get to the benefit stage earlier. All of our foreign trading partners do. In fact, many of them start with our basic research results.

This means taking advantage of the backlog of twenty plus years of discoveries. We have to find the right balance. Just enough basic research to keep the pump frying, keep the pipeline full, but significantly more exploratory in applications development.

We have to be closer to the commercialization end of the scale with more of our valuable resources.

I have a few examples of priority science and technology programs that I would like to share with you, but I am not interested in seeing the Federal Government go out and pick up any one of these and fund them individually. I think that we should work for a model that solves the general case and has the ability to fund whatever comes up.

I would like to point out again that I represent the National Center for Manufacturing Sciences. So, we have a specialized focus on manufacturing technology, and I have drawn my examples from that.

An excellent topic and one very important to the nation is computer technology and industrial controls. Overall, we have remained competitive in this field. However, if you look at the component level of these, the story is much different.

The answer is, it is going to take additional research of a specialized nature on manufacturing technology. The product technology is fairly well known. Our friends and colleagues at Semetech are attempting to address this, but let me tell you, they have a full plate and there is more to be done.

I am more concerned about industrial control technology because that is a very different story. We have already lost much of the battle to our foreign trading partners, and the fight to win back the industrial control will be very difficult.

In the manufacturing arena, this is one of the most important research topics because it is the pacing item for manufacturing competitiveness and improvements.

We recently did a study to determine whether it would be worth going out and developing a new generation of control technology, and the report revealed something very interesting. We thought it would show a very large incentive to the technology producers. Oh, it showed a very large incentive.

For roughly a $100 million investment, after three or four years of research and four or five years of penetration, about a $2.2 billion annual return on investment, net present value. Unfortunately, only about five percent of that is recognized by the equipment vendors themselves. So, they do not have incentives to go out and invest that kind of money. The incentive has to come from somewhere else in the manufacturing community, the major users.

A second national priority would be developing a broad family of precision manufacturing technology. Again, our foreign trading partners are in the lead. However, I would like to point out, we have an excellent start in this area. At Lawrence Livermore, we have a precision engineering laboratory. But the biggest organizations that have gone in there to look at that and to transfer the technology out are our foreign trading partners. Very little of U.S. industry knows about it.

It is going to take years to commercialize the technology and to extrapolate the gains that have been made there to other systems

besides a turning system. We have estimated, and I will tell you we are working on this, also, that it is going to take an investment near nearly a $100 million to achieve the commercial potential that this technology offers to us.

A third and very broad area is new materials. In fact, it is too broad to cover in any detail, but I would like to give you this particular example because it is an excellent opportunity for cooperative research. Many of our national labs are already working on new materials development, and I think the rewards could be quite great.

One area that is very important to us is diamond film coating, both thin and thick films. The reason we are interested in this is if we can commercialize the process, if we are able to convert this, reduce this to practice and coat any kind of metal with a diamond film, we have a chance in the low-temperature spectrum, under 1200 degrees C, to reduce wear on machine tools, on bearings, on gears, on slides, on anything that has any type of friction involved in it.

With respect to machine tools, we are looking at order of magnitude increases and the like. To reduce this kind of technology to practice, to get those kinds of benefits, we have estimated it is going to take nearly a $150 million.

Another area of particular interest in materials is ceramics and metal matrices. We are interested in this because of the wear and thermal characteristics of these materials. The potential applications are all around us. High-temperature tooling, gears and bearings. In fact, if we are able to improve on the characteristics of these materials, it will change engine technology dramatically. You could envision a plastic engine with ceramic inserts.

For optimal performance, you could have essentially designer materials. The material would be optimized to the application.

Getting from here to there is not going to be an easy task, and it is not going to happen overnight. Our best estimates are it is going to take at least another decade of research and development, and more than $200 million to do the kind of job that we need.

In a slightly different area, we are pursuing fiber reinforced thermoplastics. Again, this is a class of materials, and the objective of this class is improved structural performance. We can put any kind of fiber into a thermoplastic that you want, graphites, glass, metals. Again, you end up with a family and the range of applications is almost unlimited.

Obviously, the aircraft and aerospace industries would be greatly benefited by this. But that is only the obvious structural areas that most people think about. Fiber thermoplastics can actually be used to replace jet engines, including the design of turbines.

Who are the other industries? Automotives, consumer products, machine tools. We would like to replace all of the material which a machine tool is made out of today with benefit.

To get from here to where we would like to be, just to get the first of these materials into a commercialization status, we think, is going to require nearly a $150 million. We would point out that we are not the only country that is looking at this.

We recently translated one of the Japanese planning documents. Most of the materials that we are looking at, they have on their

agenda, also. Our foreign trading partners picked up the ball and they are running faster than we are.

I could go on and talk about materials for a long time, but I would like to point out one last example. Sensor technology, and you might be interested that Sandia and a number of other labs have particular expertise in that.

As we enter the age of information and knowledge, we need to improve the point of collection, the sensor. It does not matter whether we are talking about a manufacturing system which is my particular interest or we are talking about consumer products or nuclear reactors. The better the sensor, the better the processing, the better the data transmission, the better we can control and optimize the events that we are dealing with.

Obviously, at NCMS, we are concerned with sensors that impact manufacturing. We want to do things like detect tool wear. We want to do things like optimize the performance of that tool for its life or its product production. We would like to detect dynamic instabilities in the machines themselves.

A way to do that would be with in situ sensors. These are sensors that are embedded in the product material in the manufacturing process. It has applications in the aerospace product industry. To look at fatigue in aircraft remotely.

We have identified over $250 million worth of sensor research that we believe should be done.

Madam Chair, I hope that the brief overview that I have provided has been helpful in dimensioning the challenges and opportunities in front of us. They are greater than any of us could undertake by ourselves, and I suggest that we leave this hearing and place into motion the initiatives to broaden and strengthen the partnerships between government, academia and industry.

We must recognize the lead roles where each of us is best, and we must actively support each other. Real support. Not with words, but with deeds, and people and expertise, with resources and facilities and money. It will not be easy. We must plan for the long haul. The price is going to be high, but, together, with a strong partnership, I think we can succeed.

Thank you.

[The prepared statement of Mr. Miller follows:]

NCMS

House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Energy, Research and Development

Hearings on Science and Technology
Perspectives and Priorities

February 10, 1989

Argonne National Laboratory
Argonne, Illinois

Prepared by:

Edward A. Miller

President

National Center for Manufacturing Sciences
900 Victors Way
Ann Arbor, Michigan
(313)995-0300

NCMS

Madam Chair, and distinguished members of the House Committee on Science, Space and Technology, Subcommittee on Energy Research and Development.

I am Edward A. Miller, President and CEO of the National Center for Manufacturing Sciences (NCMS). On behalf of NCMS, I am extremely pleased to have this opportunity to address you today on industry's perspectives and priorities for science and technology in the decade ahead. I believe what we do now, and throughout this period, will be crucial to the long-term security and competitiveness of our nation. In this regard, I would like to confine my remarks to three specific areas:

1. The creation of NCMS, including factors motivating its membership;

2. The social, economic and regulatory environment influences on industrial consortia and science and technology, including the roles of industry, academia and government; and,

3. Our recommendations on science and technology policy and strategy including several national priorities.

First, let me begin by stating that the National Center for Manufacturing Sciences is not the result of any single individual, event, activity, or organization. Quite to the contrary, NCMS is the product of many activities and the sum of the efforts of a diverse array of individuals from many sectors of our economy and with a spectrum of roles within our society. The National Center for Manufacturing Sciences reflects the wisdom of Congress in recognizing the global changes that led to the writing and implementation of the National Cooperative Research Act of 1984. It conveys the insights and recognition by business leaders from across this nation that precompetitive research on manufacturing related technologies can be successfully accomplished in a cooperative environment.

The NCMS was formed in response to a growing concern about the declining competitive loss of U.S. manufacturing. After several decades of watching their industries being systematically decimated by foreign competition, U.S. business leaders concluded they could no longer compete individually in the rapidly changing global market. By the fall of 1985, the span and scope of the problem confronting these executives became obvious. Many of our foreign trading partners were cooperating on a national basis. In addition to the many positive and large productivity increases achieved, numerous organizations had also resorted to a spectrum of unfair trade practices. Tariffs, barriers, quotas, and dumping in industries like consumer electronics, television, machine tools,

and semi-conductors (to name just a few) stand out in history. It was against this backdrop that business leaders from the U.S. manufacturing community concluded that part of the answer to the industrial competitiveness issue was an industry-driven and industry-managed effort to rebuild manufacturing technology superiority. Their vision was shared by the Department of Defense and others who supported and encouraged their efforts to design a solution. Further, it was with a recognition of these decisions and their subsequent thrust that President Reagan established his Domestic Action Plan to support the restoration of the manufacturing technology industries.

Madam Chair, in the formative stages of developing the National Center for Manufacturing Sciences, our industry leaders, our members of today, did not have the benefit of a complete understanding of the true dimensions of the problems and tasks confronting us. While we clearly understood that our manufacturing productivity advantage had recently eroded by 30-35% and that the efforts in front of us were large, no one was wholly cognizant of the billions of dollars that were being spent annually in joint industry/government partnerships by many of our foreign trading partners. In fact, since that time, we have become aware (although with great difficulty) of a significant increase in the level, the span, and the scope of these activities throughout the world. Quite simply, this has made the task in front of NCMS and its members more difficult and the need to succeed more important. It has strengthened our resolve. Whether we are discussing European initiatives such as ESPRIT, or EUREKA, or BRITE, or any of three dozen more consortia of industry, academia and government, or we are discussing the Pacific Rim countries like Japan and its ministries and industrial consortia, or Taiwan, or Korea, or any other country, the conclusion is the same. As we transition from a domestic economy to a truly global society, the manner in which we conduct business must also change. Key to the competitiveness of our industries will be the technological leadership that we maintain in both product and manufacturing technologies.

This leads me to the second topic, which I would like to address: the environment affecting manufacturing and research and development as well as the roles for government, academia, and industry. Addressing the environment is not an easy task. However, it is without question the single most influential issue affecting the thinking of our industrial leaders and consequently, their science and technology decisions in the future. By "environment" I loosely refer to that body of external influences such as social, economic, and regulatory conditions impacting industry. More specifically, they encompass trade, tax, product liability, intellectual property rights laws and government procurement priorities and procedures, to mention just a few, as well as the educational capabilities and quality of emerging work force, or international exchange rates, or an endless list of other factors.

NCMS

Over the past two hundred years or so, our system of government and industry has served us exceedingly well. During these two centuries together we have built the greatest nation with the strongest economy and the highest standard of living known in the world. Recently, however, the environment that has served us so well in the past has begun to show signs of strain. At NCMS, we believe that the time has come to re-examine this environment and to consider those changes that will carry us far into the future and restore us to a leadership role in a global economy. We further believe that this will best be accomplished if we forge the right partnerships, that is, partnerships between governments, between industry, and between academia. Each of us has an important and essential role to play in the changes to our environment and to our undertakings in the future.

While there may be many ways to improve our science and technology environment, at NCMS we believe that one of the keys is the development of a national industrial policy. Not a de facto policy that results from inaction and not a policy that is developed in a vacuum, but rather, one that is forged with input and consensus from business leaders from across our nation. A policy not for business alone but one that is coordinated with our defense, foreign and social programs with their complex interdependencies. An industrial policy where we recognize the strengths, weaknesses and the best roles for each sector of our economy to play: government to lead and manage our nation, our states and our local economies; academia to educate our youth and improve the capabilities of our citizens; and industry to develop and produce the goods and services needed by our citizens and our foreign trading partners. An industrial policy in which each sector must play support roles as a partner in areas run by others. Today, we cheat ourselves. We do not get the best that can be obtained for our citizens from our economy. Although government, academia and industry talk together and sometimes listen to each other, more often than not we are in adversarial roles. This must change.

I do not have a new paradigm to offer that solves all the difficulties that we both know exist. Rather, I offer NCMS as an example of what can and should be accomplished and suggest ways that it can be strengthened and broadened. Earlier I mentioned that NCMS is the result of a collective wisdom. It is a consensus by the "hands on" management in our member companies. At NCMS, my staff and I lead and manage. We facilitate and create the environment that encourages and allows science and technology needs to be identified and undertaken. Our members, that is the "hands on" management of our industry, analyze, prioritize and decide.

This is a very important point because it is quite different from the operations of our public sector. At NCMS, our goal is to create a technology pull and not a push. We do not dictate research programs with which we are intrigued; quite to the contrary, we only start programs that our members indicate

they need. As a result, they have product commercialization in mind right from the beginning. Since we have both technology users and suppliers involved, we know how and if it can be produced successfully. We also know what market exists. As a result, our members are eager to undertake the research, to share in its costs and to support it in the marketplace when completed.

Let me go a little further. Today, our competitiveness difficulties are too large, too complex and too diverse for any one of us to solve individually. I refer here not to individual organizations, but to government overall, to industry overall, and to academia overall. We must work together in much the same way that NCMS and its members work together now. Scientists and engineers from government, academia and industry must stand side-by-side in the same facility, working together on the same projects. Not only does it mean cooperation instead of competition, but also each contributor must be able to achieve their goals. For industry, technology transfer and product commercialization has to be built-in right from the beginning, independent of where the actual research is conducted.

I am delighted that these hearings are being held at Argonne National Laboratory. Our nation has a wealth of resources in our federal laboratory system including Argonne. The quality of science and technology research they undertake is without question some of the very best in the world. However, as I mentioned earlier, we cheat ourselves. We do really great research and then we try to figure out what to do with the results. I recognize that we have a wealth of knowledge, know how and intellectual property from decades of past research. The Stevenson-Wydler Technology Innovation Act, the Federal Technology Transfer Act and Executive Order 12591 "Facilitating Access to Science and Technology" are a step in the right direction, but they are technology push oriented. Generally, they just are not effective.

I believe that much of the past results from science and technology research could be useful. However, to be of commercial value, it must be reviewed, analyzed and probably combined with other technology and substantial additional investment made to obtain a marketable product status. This can best be undertaken by industry consortia specializing in that technology area. For instance, NCMS could provide a valuable service on manufacturing technology and I might add, NCMS would be interested.

Having addressed our recent past, I think this is a good point to talk about our future and my third point, science and technology policy and strategy, including research and development priorities. My short and simple answer is that we must lift our focus from mostly basic research to mostly applications development.

Let me explain. I do not want anyone to misunderstand me. I believe that basic research is very important. We would not enjoy the high standard of living that we have if it were not for the discoveries and breakthroughs brought about by our basic research. The problem is that if often takes 20 years or more before the benefits of a discovery are realized by consumers. Somehow we must get to the benefit stage earlier. All of our foreign trading partners do. This means taking advantage of the 20 plus years of discoveries backlog which we have. We have to find the right balance. Just enough basic research to keep the pump primed and the pipeline full, but significantly more exploratory and applications development. We have to be closer to the commercialization end of the scale with more of our valuable resources.

I have a few examples of priority science and technology programs that I would like to share with you. Before I do, however, I would like to re-emphasize that NCMS has a specialized focus, manufacturing related technology. Over the last few years, NCMS and its membership have identified nearly two billion dollars of research which is of interest to us. I should point out that this number is low when compared to the activities and expenditure levels of our foreign trading partners which is over a billion dollars per year.

An excellent topic to begin with is computer and industrial control technology. Overall, we have remained competitive in this field. However, at the component level the story is considerably different. The answer is some research in specialized manufacturing technology. Our friends and colleagues at Sematech are attempting to address these but the pace of technological change is very rapid and they have more than a full plate.

Industrial controls technology is a much different story. We have already lost much of the battle to our foreign trading partners and the fight to win it back will be difficult. In the manufacturing arena this is one of the most important research topics possible because it is the pacing item for manufacturing competitiveness improvements. In a recent study for a new generation of control technology that we have completed, it shows a Net Present Value (NPV) after commercialization and several years of market penetration of approximately 2.2 billion dollars annually. Unfortunately, only about five (5) percent of that benefit goes to the technology supplier. This is not enough for the equipment vendors to underwrite the estimated 100 million dollar project cost.

A second national priority could be to develop a broad family of precision manufacturing technologies. Again, our foreign trading partners are in the lead. However, we have an excellent start in this area at Lawrence Livermore but it will take years of effort to commercialize this technology. From my perspective this would present an excellent opportunity to bring industry, academia and the

government together in the same laboratory to nucleate and commercialize a new industry in the United States that could provide benefits to all. Again, the magnitude of a full program would be approximately 100 million dollars.

A third and very broad area is that of new materials. In fact, it is too broad to cover in any detail, but it is another excellent example of where cooperative efforts could be rewarding. Here is just a feel for the opportunities: Diamond film coatings, both thick and thin. When the processes reach commercial viability we have the potential to eliminate wear at low and mid-range temperatures (under 1200 degrees Centigrade). Think of extending tool life by orders of magnitude, or gears, bearings, slides, guides, etc., that do not wear. There would even be a reduction in the amount of energy needed to run the equipment, to say nothing about the savings on replacement parts. However, to attain this we estimate the cost at about 150 million dollars. Ceramics and metal matrix materials would make a good second choice. Now we can expect both wear and heat resistance. The potential applications are all around us. High temperature tooling, gears, bearings and more. It will change engine technology dramatically. For optimal performance, the particular material would be tailored to the application. Getting from here to there will not be easy, and it will not happen overnight. We have estimated a decade of research and more than 200 million dollars to do the job.

In a slightly different area, we are pursuing fibre reinforced thermoplastics. The objective of this class of materials is to achieve improved structural performance. With fibre like graphite, glass, metal and more, the family of products and the range of applications is almost unlimited. The aircraft and aerospace industries would benefit greatly and not only the obvious structural components. High temperature versions could be used to fabricate many of the engine components themselves, including the blades. Clearly, other industries from the automotive, to consumer products, to machine tools, would benefit also. To get started and get the first materials of this class to commercialization is going to require about 150 million dollars. We are not the only country that has recognized the strategic importance of this area. Our foreign trading partners have picked up the ball and are running as fast or faster than we. They have already committed billions of dollars to this area alone.

I could go on for a long time, but let me finish with one last item, sensor technology. As we enter this age of information and knowledge, we need to improve the point of collection, the sensors. It does not matter whether we are talking about a manufacturing system, a consumer product or a nuclear reactor. The better the sensors and processing, the better we can control and optimize an event. Obviously, at NCMS we are concerned with sensors that impact manufacturing. For instance, to detect tool wear and optimize tool performance or detect machine dynamic instabilities and permit real time compensation. Another area would be in situ cure sensors. These sensors imbedded in the

product material itself would help optimize the manufacturing process and later could be used to monitor the health of the material itself (e.g. detect fatigue). In our view, the potential is unlimited. We have identified a need for more than 250 million dollars in this area.

Madam Chair, I hope the brief overview I have provided has been helpful in dimensioning both the challenges and the opportunities in front of us. They are greater than any of us can or should undertake by ourselves. I suggest that we leave this hearing and place into motion the initiatives to broaden and strengthen the partnership between government, academia and industry. We must recognize the lead roles where each of us is best and we must actively provide support to each other. Real support, not with words, but with deeds and people and expertise - with resources and facilities and with money. It will not be easy. We must plan on the long haul. The price will be high. But together, with a strong partnership, we will succeed.

Thank you.

Mrs. LLOYD [presiding]. Thank you very much, Mr. Miller.

Now, we look forward to hearing from Mr. Egils Milbergs, President of the Institute for Illinois.

Egils, it is certainly a delight to be here with you. We do appreciate your leadership, and we look forward to hearing from you.

We hope that we can finish up this section of our hearing before we break for lunch today.

Please proceed.

STATEMENT OF EGILS MILBERGS, PRESIDENT, INSTITUTE FOR ILLINOIS

Mr. MILBERGS. Thank you, Chairwoman Lloyd, and members of the committee.

I am delighted and honored to have the opportunity to provide testimony on a very important subject, mid-America science and technology priorities.

Our challenge is to learn faster than the competition, and I believe that this is a competitive advantage we need to build in the region.

I would like to enter my full testimony into the record.

Mrs. LLOYD. Without objection, it will be made part of the record. Your complete testimony. You may proceed as you wish.

Mr. MILBERGS. Thank you.

I am president of a unique organization, the Institute for Illinois. My background includes being the executive director of the President's Commission on Industrial Competitiveness, and also Deputy Assistant Secretary of Productivity Technology and Innovation at the Commerce Department.

Bruce Merrifield and I had the principal responsibilities since 1980 for the Stevenson-Wydler Act and the Federal Technology Transfer Act.

My big challenge is to move essentially new policies that were put together in Washington, inside the Beltway, and move these policies in terms of implementation down to the state level.

The Institute was formed in 1985 by the Illinois congressional delegation as a bi-partisan public/private corporation to promote the state's economic and technology vitality.

Our board includes members of Congress, academic institutions and the business community. We are privately financed. Initial funding was provided by the MacArthur Foundation. We are currently supported by contributions from the business community.

The major force for establishing the Institute was the recession of 1982-83, and the fact that the Civic Committee of the Commercial Club came out with a report indicating that Illinois ranks forty-ninth in terms of federal funds received relative to taxes paid.

Last year, the Institute approved its "Blueprint for Action". We charted a road map for building a sustainable competitive advantage for Illinois. It is an action program. It is based on building a network of alliances and public/private partnerships aimed at penetrating new markets, domestically and internationally; accelerating the commercialization of technology; and improving the quality of the work force, and, I might add, to creatively use federal resources in new and different kinds of ways.

We are especially interested in the question of making a stronger linkage between the creators of technology and the users of technology and designing technology transfer into the process.

Our goals include organizing cooperative R&D initiatives and increased industrial access through joint research to federal laboratory technology. We believe by strengthening the linkages between separate institutions, we can increase the research, development and commercialization capacity of the state and thereby create a more productive research dollar.

Our present portfolio of projects we are evaluating and supporting include the advanced photon source, super computers, high-definition television, super-conductivity, flexible shared manufacturing centers, information technology for the service sector, clean-coal technology, and critical defense technologies.

These projects, we estimate, will require over $600 million in federal funds. We have found that federal funds can be a critical factor in encouraging cooperation among competing institutions and leveraging additional private and state R&D investments towards important national goals.

I would like to illustrate the point with a couple of examples. The Bio-technology Research and Development Corporation. A first-of-a-kind cooperative effort involving seven international corporations, a federal laboratory in Peoria, Illinois, and a great university, the University of Illinois.

It was launched in March of 1988. The objective of this program is to develop environmentally-safe pesticides from natural plant products, increased marketability of soybeans through new industrial oils, new antibiotic compounds, and industrial production of protein.

We are talking about higher value-added processing in the underlying manufacturing process using new products made from this technology.

The Federal Technology Transfer Act was absolutely critical in the creation of this partnership. Without that Act, this partnership would not have been possible. The funding for this program will reach $20 million during its first five years. The Federal Government will provide $10 million. The State of Illinois $4 million, and the seven member companies $6 million. Corporate members include American Cyanamide, Amoco, Dow Chemical, Hewlett- Packard, International Minerals and Chemicals, the Agriculture Research and Development Corporation.

It is also interesting what created this consortium. It was a joint venture between the venture capital arm of a local utility and a local economic development organization, Economic Development Council for the Peoria Area.

From the Institute's perspective, we view this project as a viable model between an industrial consortiam and the national laboratory system. This formula of cost and risk-sharing between the state, federal and private investment in consortia-based R&D will be replicated in several new ventures we have currently underway.

Another area we have been working on is superconductivity, and Alan Schriesheim has addressed that. Let me just point out that the Federal Government in this case got four research institutions to work together. The $25 million NSF grant led to a consortium

between the University of Illinois, Northwestern, the University of Chicago, and Argonne, with the support of the state government.

Without this federal commitment, I am convinced that this kind of cooperative relationship between the laboratory and the universities would not have taken place.

A third point. Community colleges are an essential link in improving the manufacturing competitiveness of the nation, but, too often, community colleges are the stepchildren of the state's higher education system. They are generally bypassed as recipients of federal technology funds.

Local community colleges provide the training and retraining that workers need to keep par with technological change. To me, community colleges are the right institutions in the right place at the right time. In Rockford, Illinois, the local community, facing the prospect of global competitive challenges, passed an $8.8 million local bond issue, no federal or state money, to set up a manufacturing technology center serving 800 small to medium sized manufacturers.

The important point here is to build a national technology transfer system as called for in the legislation of the Trade Bill. One can rely upon local citizens to finance a large part of these technology transfer activities, and there is an opportunity to link many of these grassroots tech transfer efforts toward a national system.

Another example of cooperative behavior is joining the big business system and the small business system to address the concern about quality manufacturing today. A company like Motorola, which won the First Malcolm Baldridge National Quality Award last year, has gone into a partnership with small business.

We can build the linkage between big business and small business and create the environment for joint product development between small business and big business.

I think we need to avoid artificial distinctions between what is called the large and the small business, but create a closer linkage. Motorola is doing just that. The Institute is working with the Department of Defense in designing a "Quality First" program for Illinois manufacturers as a means of building a more competitive and effective defense industrial base to serve our national security needs.

My major conclusions from these examples. First, that there are valuable lessons to be learned from the experience of state-based technology development programs. The mid-America region is a living laboratory of innovative approaches. One lesson that is very clear is that cooperation among national laboratories, universities, state-local government and federal programs is crucial if we are to meet the challenges of a more globally-competitive and technological age.

Secondly, that Illinois and mid-America have substantial scientific and technological assets to create a partnership for progress with the Federal Government to solve many of our key technological challenges. However, while the states in mid-America have been leaders in fashioning these new enabling institutions for science and technology, the region has lagged far behind the rest of the nation in the amount of federal research and development money received.

Despite large increases in total federal funding from $23 billion in 1977 to $54 billion in 1987, the per capita spending in the seven states of mid-America, Illinois, Indiana, Minnesota, Wisconsin, Ohio, Michigan and Pennsylvania, averaged $101 per capita. This is less than half the national per capita figure of $220, and far less than the $348 average for twelve coastal states.

The seven states in this region have a budget of a $163 million for science and technology programs. That is about thirty percent of the national state level investment in science and technology. The region has $20 billion of industrial research and development that is spent by corporations on their own.

The Federal Government, by more aggressively participating in this region, can help strengthen the partnership among these sectors.

My major suggestion to federal policy makers is that national R&D investment be re-evaluated in terms of how it supports the competitive fundamentals of the region and the other regions around the country.

One conclusion such an examination will reach with respect to mid-America is that a greater emphasis be placed on process technology development in Department of Defense R&D and civilian agencies. This is particularly needed if we are to restore our international competitiveness.

The U.S. has suffered a notable lag in applying our science and engineering to process technology manufacturing. We originate many of the new manufacturing technologies, including automation, robotics, statistical quality control, but we have not kept pace with foreign nations in the adoption of these technologies.

The Japanese have recognized the importance of concurrent engineering and reducing cycle time, the stage between prototype design and full-scale production, and as a result, they often take product ideas into full-scale production in half the time that we require. These are central challenges and issues for such areas as supercomputers, superconductivity, high-definition television, etc.

We need to change our thinking about the nature of the innovation process. We have a model that is a technology-push or research-driven model of innovation. This model views innovation as a linear process, starting with major scientific breakthrough, progressing through design, development, production and ending in marketplace distribution.

This model was fine when we had a monopoly on technology in the world, but, today, we need to change or refocus the model on a market-driven model of technology. The new model suggests that innovation is better described as an inter-active or reiterative interdependent process in which design, manufacturing, product development all drive research, and at the same time are highly dependent on research.

Making the transition at the federal level from a technology-push mission-oriented R&D approach to a market or competitiveness-driven approach is the next crucial and important step.

The second point I would like to leave you with is that we need to create a federal focal point for technology partnerships. There is a great recognition that problems we face are not able to be solved through traditional institutions and charters. There is not an oper-

ational focus for this cross-cutting responsibility in the Executive Branch.

An immediate opportunity is to support the Department of Commerce and the National Institute of Standards and Technologies new emphasis on technology transfer and commercialization, with full appropriations to forge these new alliances between federal agencies and consortia of industry.

The new Under Secretary of Technology could help shape the new area of federal R&D investment in the service sector. The service sector is largely ignored in government-funded research activities. However, it accounts for three-quarters of our national employment and two-thirds of the GNP and we are beginning to face major competitive problems in the service sector.

And, finally, we need to provide some incentives to foster alliances from the point of view of industry. Great progress has been made in the past few years in removing federal institution obstacles to participation in cooperative R&D ventures with industry. The Stevenson-Wydler Act, the Federal Technology Transfer Act, and your proposed legislation as well are very important. They have decentralized deal-making authority to laboratories and clarified intellectual property rights, etc.

But the issue now is how we create the partnership with industry—how we strengthen the incentives from the industry demand market side point of view. There are serious obstacles.

A number of policy areas need to be investigated. First, antitrust laws. In particular, the Clayton Act should be examined as a potential barrier to technology commercialization. Current law provides for joint research activities. However, subsequent scale-up in the expenditures for engineering prototypes, etc., and in terms of technical skills required for commercialization may require joint production, maybe even joint distribution and marketing approaches if we are to meet the challenges of global competition.

Secondly, the effectiveness of the R&D tax credit has been diminished considerably because of the uncertainty of its availability. Furthermore, it provides a limited incentive towards facilitating external linkages with universities, federal laboratories, start-ups and industrial consortia.

The current debate over the future of the credit suggests an opportunity to examine the feasibility of a more targeted credit to stimulate such linkages and alliances. Combined with a cap, a redesigned R&D tax incentive and a permanent incentive would have a more significant effect and be of lower cost to the government.

And, finally, the Department of Defense, which is a major purchaser of manufactured goods, should redesign its acquisition and procurement procedures to encourage investment in quality and productivity-enhancing technologies.

I am very impressed by the report called "Bolstering the Defense Industrial Base", which lays out a series of recommendations which should be implemented as quickly as possible.

I think we need to get on with it. The states are providing us the laboratory and testing various strategies. They are creating viable options for national investment. Our experience in Illinois teaches us that cooperation among the sectors is crucial to developing a world class research, development and commercialization program.

By leveraging public and private R&D resources and building new alliances to open markets and utilize technology, I believe mid-America can build a sustainable competitive advantage and become a role model for the nation.

Thank you, Madam Chairman.

I would be pleased to answer any questions.

[The prepared statement of Mr. Milbergs follows:]

MID-AMERICA SCIENCE AND TECHNOLOGY PRIORITIES

Statement

of

EGILS MILBERGS
President
Institute for Illinois

Presented

to

The Subcommittee on Energy Research, and Development

of

The Science, Space, and Technology Committee

U.S. House of Representatives

February 10, 1989

MID-AMERICA SCIENCE AND TECHNOLOGY PRIORITIES

Statement of Egils Milbergs
before the
Subcommittee on Energy, Research, and Development
Committee on Science, Space, and Technology
U.S. House of Representatives

Madam Chairwoman Lloyd, members of the Energy, Research, and Development Subcommittee, I am honored by this invitation to provide testimony to the Subcommittee on Energy, Research, and Development. I want to thank the committee for providing this forum to exchange information on the issue of science and technology in Mid-America. Our challenge is to learn faster than our competition. This appears to be our only competitive advantage.

The Institute for Illinois

I am president of a unique organization, the Institute for Illinois. My background includes being the Executive Director of the President's Commission on Industrial Competitiveness and Deputy Assistant Secretary of the U.S. Commerce Department for Productivity, Technology and Innovation. These experiences have prepared me for my most challenging task - implementing a statewide competitiveness strategy for Illinois. This challenge is to move beyond being an architect of new technology policies to the front lines of state based development.

** The views expressed in this testimony are those of Egils Milbergs as President and should not be construed as representing the views of the Institute's Board of Directors and Members.

The Institute was formed in 1985 by the Illinois Congressional delegation as a bipartisan, nonprofit corporation to promote the State's economic and technological vitality. Its Board of Directors includes members of Congress, chief executives from the business community and leaders of academic institutions.

The Institute's operations were initially financed from the MacArthur Foundation and are currently supported by contributions from the Illinois business community. A major force for forming the Institute was the economic adjustment problems caused by the recession of 1982 and '83. The State has lost over 21% of its manufacturing jobs and a new organization was required to complement existing public and private institutions. Its role was to change Illinois' reputation as the "buckle of the rustbelt."

Last year the Institute approved its "Blueprint for Action." We charted a roadmap for building a sustainable competitive advantage for Illinois. It is an action program based on creatively applying federal resources for aggressive market development, technology application and human resources. More importantly, it is a results driven economic agenda for Illinois. The Institute's strategy is to build a network of alliances and public/private partnerships aimed at:

- Penetrating new markets domestically and internationally;
- Accelerating the commercialization of technology;
- Improving the quality of the workforce; and
- Leveraging federal resources.

Laboratories of Democracy

In an environment in which federal funds will be increasingly constrained, there are valuable lessons to be learned from experience of state based technology development programs. The real ferment and innovations in economic policy today are occurring at the state level. Out of these unique experiments, the United States has an opportunity to evolve a new economics and national agenda for a more globally competitive and technological age. No longer is smokestack chasing a major priority for most states. Rather they are aggressively investing in scientific and technological infrastructure.

To quote from Supreme Court Justice Louis D. Brandeis in his observations about the states, "There must be power in the States and the Nation to remold, through experimentation, our economic practices and institutions to meet changing social and economic needs. It is one of the happy incidents of the federal system that a single courageous State may, if its citizens choose, serve as a laboratory, and try novel social and economic experiments without risk to the rest of the country."

Mid-America states have fashioned individual agendas which are innovative, energetic, and require sometimes tough decisions in the use of their resources. To further these initiatives and economic development goals, new and strengthened partnerships are needed - regionally, as well as with the federal government. The future of the region and Illinois, in particular, will primarily rest on the capacity to understand our strengths and weaknesses

and accordingly mobilize our individual resources in cooperative ways.

Federal R&D priorities and resources are a significant influence on Mid-America's economy. A partnership with the federal government must be built which recognizes the role Mid-America can play in solving our most pressing scientific and technological problems. It is states and regional areas that in the first instance confront competitive challenges. They are a major mechanism to alert federal agencies and Congress to the type of research needed to solve them.

INSTITUTE'S TECHNOLOGY APPLICATION PROGRAM

The purpose of the Institute's technology application program is to accelerate the application of research and technology to Illinois' existing and emerging economic base. We are especially interested in strengthening the linkages between the creators and users of technology and designing technology transfer into the process. Our goals include organizing cooperative R&D initiatives and increased industrial access through joint research to federal laboratory technology. We believe by strengthening the linkage between separate institutions we can increase the research, development, and commercialization capacity of the State and thereby improve long-range economic prospects for the State and region.

To achieve this goal, the Institute identifies specific projects and targets of opportunity and supports the creation of

federal, state, and private coalitions of interests necessary to bring the project to fruition.

Project selection depends on evaluating project opportunities on three criteria:

- Economic impact of the project;
- Technical, management and manufacturing capabilities; and
- Potential to leverage federal, state, and private financial resources.

We have found that federal funds are an important catalyst for stimulating the formation of cooperative ventures that meet these criteria. Indeed federal funding can be an important factor in encouraging cooperation among competing institutions and leveraging additional private and state R&D investment toward important national goals.

Our present portfolio of projects we are evaluating and supporting include:

- Advanced Photon Source
- Supercomputers
- High Definition Television
- Superconductivity
- Flexible Shared Manufacturing Centers (Gears)
- Information Technology for the Service Sector
- Clean Coal Technology
- Critical Defense Technologies

These projects we estimate will require over $600 million in

federal funds.

Increased R&D investment, however, from any source does not assure economic competitiveness. The quality of education, the cost of capital, access to markets, the supply of trained scientists and engineers, farsighted management, state and local policies, all of these and other factors shape the competitiveness equation. What is especially encouraging is that we are now creating the enabling institutions to integrate these factors into viable results oriented programs.

I will illustrate this point with a few examples.

Biotechnology Research Consortium

This first of a kind cooperative research and development consortium, made up of seven companies using public and private funding to conduct biotechnology research and development, was launched in March 1988.

The objective of the research is to develop environmentally safe pesticides from natural plant products, increased marketability of soybeans through new industrial oils, new antibiotic compounds and industrial production of protein. Formation of the consortium was made possible by the Federal Technology Transfer Act passed by Congress and signed by President Reagan in October 1986.

This project is viewed by the Department of Agriculture and Department of Commerce as a model program involving cooperative research between government, private industry and university

organizations. The member companies have both competitive and diverse markets within their operations, yet they have come together in a cooperative research effort - the belief that there is value to be gained by leveraging research dollars and sharing in basic research efforts.

Funding for BRDC will reach at least $20 million during its first five years with the federal government providing $10 million, the State of Illinois, $4 million and the seven member companies accounting for another $6 million.

Corporate members are American Cyanamid Company, Wayne, New Jersey; Amoco Technology Corporation, Naperville, Illinois; The Dow Chemical Company, Midland, Minnesota; Ecogen, Inc., Langehorne, Pennsylvania; Hewlett-Packard Company, Palo Alto, California; International Minerals and Chemical Corporation, Northbrook, Illinois; and the Agricultural Research Development Corporation (ARDC), Peoria, Illinois.

The project was four years in the making and was organized by ARDC, a joint venture between CILCORP Ventures Inc. and the Economic Development Council for the Peoria Area. The Institute for Illinois played an instrumental role in gaining a final commitment from the Department of Agriculture. The research consortium will work in collaboration with the United States Department of Agriculture's Northern Regional Research Center in Peoria and the University of Illinois' Biotechnology Center in Urbana.

From the Institute's perspective, we view this project as a

viable model between an industrial consortium and the national laboratory system. This formula of cost and risk sharing between state, federal and private investment in consortium based R&D will be replicated in several new ventures currently underway.

Superconductivity

We are working to compliment the research strength of Argonne National Laboratory in superconductivity and promote a long-term commercialization strategy with state government and the private sector.

The State recently was awarded a National Science Foundation grant of $25 million for a Research Center for High-Temperature Superconductivity (HTS). This center will help position Illinois as the leading American player in the race to develop commercial applications for superconducting materials.

The grant is particularly satisfying because it represents an unprecedented cooperative effort among four great research institutions in the State -- the University of Illinois, Northwestern University, University of Chicago and Argonne National Laboratory -- with the support of the state government and members of the Illinois Congressional delegation.

Community Based Manufacturing Technology Center

During the 1970s, Rockford, Illinois, northwest of Chicago, was a manufacturing Mecca. After the recession of 1981-82, there was a steady decline in manufacturing employment. The community

realized that developing a new technology base was one of the few options during this period of high unemployment and anxiety. An $8.8 million local bond issue was proposed and approved in 1986 which provided the resources for establishing a Manufacturing Technology Center at Rock Valley Community College to serve 800 small to medium sized manufacturing companies.

The Center is designed to teach, train, and retrain the existing workforce as well as demonstrate and provide hands on experience with state-of-the-market manufacturing technology and equipment. This local involvement made it possible for Illinois to join with Minnesota in the competition for the so-called "Hollings Center" for manufacturing.

One of the most underutilized technology transfer mechanisms to assist industry implement new technology is the community colleges. Business people realize that it is not just high-tech machinery or technology that will make a difference; it is a workforce and management knowledgeable about how and when to employ the latest technology and concurrently integrate technology with quality and productivity improvement methods.

Community colleges are an essential link in improving the manufacturing competitiveness of the nation. Too often, community colleges are the stepchildren of state's higher education system and are generally bypassed as a recipient of federal technology funds. Local community colleges provide much of the training and retraining that workers need to keep par with technological change. Community colleges are the right

institutions, in the right place, at the right time.

An economic opportunity exists to link the new technology transfer programs authorized in the Department of Commerce with the nation's community college system. Moreover, the Rockford example shows that local voters will approve new tax revenues to support community based technology transfer programs.

Quality Manufacturing

Quality manufacturing is a business strategy that results in rapid improvements in the use and transfer of technology. Total quality control practiced by companies like Motorola extends upstream to suppliers and downstream to the distributors and to the customer. The demand for higher quality products and more efficient production techniques stimulates the demand for both new process and product technology.

Quality oriented programs allow early involvement of suppliers in the product-development process. An environment can be created for an exchange of technologies. These relationships demand complete confidentiality and an understanding of how the benefits of research will be applied and shared. This approach encourages technology transfer. The Institute is building a market demand for technologies through an emphasis on quality manufacturing.

Motorola, an Illinois-based firm, won the first Malcolm Baldridge National Quality Award in 1988. The award was a culmination of ten years of increased attention to quality.

Robert W. Galvin, Chairman of Motorola, insists on quality production "as a way of life." Motorola has found that making better products saves money, increases sales, improves international competitiveness and permits rapid commercialization of new technologies. The Motorola program involves:

- Pruning of vendor base to those with a commitment to quality
- Closer relations with design and manufacturing engineers
- A quantum jump into part-by-part sole sourcing, to take advantage of volume economies and suppliers' know-how
- Intensive training of suppliers in techniques such as statistical process control (SPC) and just-in-time scheduling (JIT)
- Longer-term contracts that encourage suppliers to become business partners

Qualified suppliers have the opportunity to participate in long-term relationships and outstanding performance is regarded with certified supplier status, increased business, and preference over competitors. Certified suppliers will also have the opportunity to advance the state-of-the-art of the industry by participating in joint projects that will involve the suppliers early in the product-design stage.

In conjunction with the Department of Defense, the Institute for Illinois is designing a "Quality First" program for Illinois manufacturers as a means of building a more competitive and cost

effective defense industrial base to serve our national security needs.

Mid-America Science and Technology Infrastructure

These examples make clear that the science and technology elements are present to create a sustainable competitive advantage in Mid-America. State governments in the region are leaders in innovative science and technology programs. The region is home to 50 federal laboratories, many successful technology parks, and top ranking universities and research centers. These academic and scientific resources should be linked together with state and industry strengths to assist in the economic growth of the region. Even though the resources may be extensive, monitoring and increasing investment in the region is integral to fostering scientific productivity and maintaining the competitive status of these facilities.

Despite the enormous increases in federal R&D funding during the 1980s, the Mid-America region continues to receive a disproportionately low share of federal R&D funds. The Institute for Illinois, in conjunction with the Council of Great Lakes Governors, has published a report on Science and Technology in Mid-America. The data is quite revealing about the federal funding situation in Mid-America. Federal R&D spending increased from $22.8 billion in 1977 to $54 billion in 1987. In 1987, federal support for R&D totaled $54 billion with the Mid-America region receiving slightly more than $5 billion.

- On a per capita basis, R&D support for Mid-America is well below the national average. Federal R&D averaged only $101.34 per capita in Mid-America, representing less than half the national per capita average of $219.78. This disparity is even greater between the Mid-America and the coastal states, which average $347.51 per capita. (Coastal states include: Alaska, California, Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, Washington.) A "bi-coastal bias" has continued to accelerate during the past ten years, making Mid-America less competitive. The coastal states nearly tripled their respective shares of federal funds received, while Mid-America has only doubled.
- Most of the states in Mid-America also have a low rate of return on federal taxes. For example, in Illinois there is a $13 billion negative net balance between the federal taxes paid by Illinois corporations and individuals and the purchase and/or expenditures made by the federal government in the state. Illinois ranked 47th in 1987 in per capita distribution of federal funds. Over 65% of federal funds that flow to Illinois are in the form of transfer payments which have a limited multiplier effect as compared to developments funds such as R&D, facilities, procurement, education, and transportation. Other Mid-America states have similar structural problems in federal funding.

- The Mid-America region has a high concentration of industrial R&D. Those expenditures totaled $19.7 billion for 1985, of which $2.4 billion came from federal funds. Illinois, Indiana, Michigan, Minnesota, Ohio and Pennsylvania are among the top twenty states nationally in industrial R&D spending.
- State governments in the region have been leaders in science and technology expenditures. It is estimated that total state expenditures for technology were over $543 million, with Mid America accounting for $163 million or 29% of the national total. Pennsylvania, Minnesota, Wisconsin and Ohio were among the top ten states with the largest amount of state technology funding. On a per capita basis, Minnesota, Pennsylvania and Wisconsin were among the top ten.

States are increasingly willing to make R&D investments for economic competitiveness. States are reshaping the research and development agenda of the nation by responding to the special requirements of the regional economy. State sponsored R&D investments are significant when viewed within the context of their own state budget but small compared to the overall national R&D effort. However, the small state investment can leverage public and private R&D investment into productive partnerships with commitments and assistance from the federal government.

NATIONAL R&D PRIORITIES

The rapid decline of Mid-America share of federal R&D has more to do with the changing priorities of the government and these changes do not bode well for the competitiveness of America.

After reviewing the data on the discrepancy between Mid-America's funding and other areas the questions that arises are: Are we investing adequately for the long term to sustain the technological infrastructure of the region? Are current R&D priorities the best way to advance national competitiveness? These are compelling issues even if the budget climate were better. Given deficit reduction pressures on spending, there is an even greater premium on making the best informed budget allocation possible.

1982 was a watershed year for Mid-America, not only was the recession in full force, a major change occurred in federal R&D priorities that were not relevant to the industrial structure of the region.

The change occurred in 1981 when the DOD funding increased rapidly as a share of the national R&D budget. Since that time, Mid-America began a precipitous drop in its share of national R&D funding. This change in market share is directly related to the change in national R&D priorities and the type of research pursued. The emphasis was on supporting defense related product technology and basic research. Mid-America is a case study in why federal priorities, procedures and procurement do not serve

97-750 0 - 89 - 5

the competitive requirements of Mid-America.

Three conclusions are implied:

1) The ability of the nation to meet global competition, to provide for the national security, and to improve the quality of life for all citizens does not merely depend on the quantitative investment in science and technology. It depends upon the focus of research and relevance to the economic base.

2) The rapid escalation of federal R&D since 1982 has not been relevant to the research infrastructure and competitive commercialization problems of Mid-America. If the priorities of Mid-America are not met then the productivity of the nation will slow.

3) Technology transfer must be designed into the R&D process through federal, state and private cost and risk sharing ventures. The issue is not whether to merely increase federal, state or private R&D, it is how new enabling institutions can be designed to leverage each sector.

My major suggestion to federal policy makers is that national R&D investment be reevaluated in terms of how it supports the competitive fundamentals of the region. One conclusion, such an examination will reach, is that a greater emphasis be placed on process technology development by DOD and civilian agencies.

The US has suffered a notable lag in applying our science and engineering to process technology and manufacturing. While the US originated many new manufacturing technologies - including

automation, robotics, and statistical quality control - it has not kept pace with foreign nations in the adoption of these technologies. The development of volume production equipment and processes may require more complete technology than product development itself. The Japanese have recognized the importance of concurrent engineering and reducing cycle time - the stage between prototype design and full-scale production - and, as a result, are often able to take product ideas into full-scale production in half the time we require.

The lack of technological competitiveness in the US does not reside primarily in the supply side of the equation. America can produce the research. Indeed it leads the world in total R&D investment. Creating a competitive economy requires new ways to organize the demand side so that industry can absorb research results quickly. Preeminence in science does not automatically confer technological and commercial success.

We need to change our thinking about the nature of the innovation process. America's post-war preeminence resulted largely from a technology push or research driven model of the innovation process. This model views innovation as a linear process - starting with a major scientific breakthrough, progressing through design, development and production, and ending with marketplace distribution. That model was fine when America had a monopoly on emerging technology. The research and business procedures that developed many of our greatest companies would bankrupt them now. The technology push model must be

supplemented by another view that focuses more on market-driven applications of technology. The new model suggest that innovation is better described as an interactive or reiterative, interdependent process in which design, manufacturing and product development all drive research and at the same time are highly dependent on research. When discussing or implementing policy, the distinction between technology push from the laboratory versus marketplace pull is critical.

The government should support but not lead with these new state initiatives. We need to organize consortia to become the hunters, gatherers, and developers of knowledge for a specific global market objective. Making the transition from a technology push, mission oriented R&D approach to a market or competitiveness driven approach is the next crucial and important step.

A FEDERAL FOCAL POINT FOR TECHNOLOGY PARTNERSHIPS

There is a growing recognition that the problems we face may not be able to be solved through traditional institutions and their charters. There is little doubt that a key factor controlling the competitiveness of the U.S. as we approach the 21st century will be how well our science and technology base is matched to industry's technological needs. Yet within the federal government there is not an operational focus for the cross cutting responsibilities.

The rapid commercialization of technology, particularly

technology developed at federal laboratories, requires a more coordinated approach to resource allocation and strategy. A number of proposals ranging from a Department of Science and Technology to a strengthened Science Advisor and OSTP have been proposed by various commissions and study groups. Many of these proposals face long-term institutional and political difficulties. An immediate opportunity, however, is to support the Department of Commerce and the National Institute of Standards and Technology new emphasis on technology commercialization with full appropriations to forge interdisciplinary alliances between federal agencies and consortia of industry. The current budget process which is designed primarily to consider how each agency's program contributes to its mission, will often inadequately address the requirements of interdisciplinary, cross-cutting areas.

The new Undersecretary for Technology could help shape a new area of federal R&D investment in the service sector. The service sector of the economy represents three quarters of national employment and two-thirds of the GNP. The "measured" productivity of this sector has been well below the manufacturing sector during the 1980s. The international trade balance in services is also facing the prospect of going negative. Despite all this, the service sector is largely ignored in government funded research activities. The largest activity within the service sector is healthcare (11% of the GNP and rising rapidly). A major opportunity to control costs is in the design and use of

information systems used in health care delivery systems. The productivity of the health care delivery system can be greatly enhanced.

The Institute has been working jointly with the Information Industry Council to establish a regional Service Industries Productivity Center in Chicago, Illinois, since Chicago is centrally located in Mid America and itself a major service center for health care.

INCENTIVES TO FOSTER ALLIANCES

Great progress has been made in the past few years in removing federal institutional obstacles to participation in cooperative R&D ventures with industry. The Stevenson - Wydler Technology and Innovation Act and subsequent amendments such as the Federal Technology Transfer Act decentralized "deal making" authority to laboratories and clarified the disposition of intellectual property rights. Agency implementation, while slower than I would like to see, has been proceeding. A notable example is the ARCH Corporation, a joint venture between Argonne, the University of Chicago, and the business sector.

The issue now is how to strengthen incentives for industry to participate with federally funded research institutions. There are serious obstacles to technology transfer that exist in private industry including the reduction of strategic expenditures in favor of short-term economic gains.

- Antitrust laws, in particular the Clayton Act, should be

examined as potential barriers to commercialization. Current law provides for joint research activities. However, the subsequent scale up in expenditures and technical skills required for commercialization may require joint production, distribution, and marketing approaches.

- The effectiveness of the R&D tax credit has been diminished because of the long-term uncertainty of its availability. Furthermore, it provides a limited incentive toward facilitating external linkages with universities, federal laboratories, startups, and industrial consortia. The current debate on the future direction of the credit suggests an opportunity to examine the feasibility of more targeted credit to stimulate such linkages and alliances. Combined with a cap, a redesigned R&D tax incentive could have a more significant effect and be of lower cost to the government.
- DOD, as a major purchaser of manufactured goods, should redesign its acquisition and procurement procedures as recommended in its recent report, "Bolstering the Defense Industrial Base." The report calls for:
    - o Commercial specifications and processes
    - o Emphasis on process technology
    - o Factory modernization Investments
    - o Program Stability with multi-year contracts

With these changes, industry will have a powerful incentive to invest in quality and productivity enhancing technologies.

We need to get on with it. The states are providing us the laboratory and testing various strategies. They are creating viable options for national investment. Our experience in Illinois teaches us a valuable lesson: Cooperation among universities, national laboratories, state and local government and federal programs is crucial to developing world class research, development and commercialization programs. By leveraging public and private R&D resources and building new alliances to open markets and utilize technology, Mid-America can build a sustainable competitive advantage and become a role model for the nation.

Mrs. LLOYD. Thank you very much, Egils.

This is a very distinctive panel and I want to congratulate you because each of you brought a somewhat different perspective to the topic of increasing our competitiveness and working together.

I think that so far we have identified our problems, that we do live in a global society. We have to produce new technology and new products and get them to the marketplace, so we can increase our income, turn around our trade deficit, and enhance our quality of life in our country.

At one point, I think that we need to go back to the focus of this committee. This committee is responsible for research and development the activities of our non-weapons laboratories to make the most of this potential.

It has been regarded that the federal agents, ideally, such as the Department of Energy, should take on the high risk, the high costs and the futuristic technology development act. Sometimes this is extremely painful because I am forced to make real selective judgments as the chairperson of this committee in that I do see technology that is really ready to go to the marketplace. Sometimes we hang on to that we do not always have adequate funding for because we realize that our mission is to take on the long-term investment that the private sector really just cannot handle.

This is extremely painful. It is going to get more painful as we proceed, but to be a partner with the private sector, to help the private sector do what the private sector cannot do for itself, and, therefore, some of the things that we would like to do, we simply cannot do.

At the same time, I think I have to agree with the statement Dr. Schriesheim made last night, that, you know, we cannot change the mission as much as we would like to of our national laboratories. They do have a mission, but we want to take advantage of what the national laboratory is doing to the best of our ability and transfer this to the private sector.

The Department of Defense as well as the Department of Energy must realize that if we are going to have the tax dollars to continue to finance our activities in both areas, that we have to have help to bring the tax dollars in. I think that basically starting out with what you have done and Mr. Miller's testimony, that he wants more federal dollars in this area, that we are caught in the middle, and this is a real problem for us. We do not have the answers, but, there again, I think I must remind you that the Federal Government cannot be the answer to all the problems of the country, that we are to help and be a partner, that again is our role.

I would like you all to comment on my perspective from your perspective.

Dr. SCHRIESHEIM. Well, I might just amplify slightly on the discussion, Madam Chairman, that we had last night on that particular subject.

That is, that has to do with the role of the national laboratories in this whole arena of national competitiveness, which is essentially what we are about in this particular discussion, and what—how can we be—the national laboratories deal with what is in a very real sense an old mission, but a new mission re-emphasized.

That is, the labs, of course, have had a long history in transferring technology to industry. Whether or not we are pro- nuclear or anti-nuclear, it is certainly true that the nuclear industry came out of the national laboratory in one form or another.

The point, though, that I had made, and that is that the way I view it, the national laboratories are a laboratory for corporate America or a—I am sorry. I misphrased that. The corporate laboratory for America.

If you view that America has certain problems that require technological solutions, environmental problems, nuclear problems, materials problems, so forth, these problems then demand an institution that has the resources, weapons problems, we are talking about the weapons problems, energy problems, institutions that have the capability, technological capability, to deal with those problems, and those are certainly essential missions of the laboratories as a corporate laboratory for America.

Then, there is the issue of being a laboratory for corporate America, which is the different issue, and corporate America has a lot of laboratories that it has itself for corporate America.

Our challenge is not, I believe, to convert the national laboratories into laboratories for corporate America, but to take the concept of a corporate lab for America and then attempt to couple into corporate America, and have the Federal Government act as a capitalist in that role, to do that, to ease the way of doing it.

I know, you know, this is a conversation we could spend all day on, but, certainly, and I can certainly spend all day on it because of all the interactions that we have, but I think I would like to make just one really brief comment, and that is one that is obvious to those of us who attempt to cross the inter-face.

One of the real advantages of the United States is its pluralism and if any place that is true, that is in corporate America. We do not deal with a corporate American entity per se. We deal with the Bell Companies and IBM and DuPont and those are one end of the sophistication scale.

On the other end of the sophistication scale are all of the tool and dye and, oh, manufacturers and other groups, all of the venture capitalists that form the small companies. They can be extraordinarily sophisticated, but, you know, lack a lot of the capital structure of the big companies.

So, in terms of what has to be done and we have to recognize that there are these various corporate Americas, that the relationships have to be structured to deal with. Both we have to be cognizant of, Congress has to be cognizant of that, and, of course, just cannot pass one bill that takes care of everything. That is simply not possible.

So, in the sense that you ask this question of the missions of the laboratory and the ability to deal and transfer technology, if anyone has ever spent time inside the company, Ralph Bomerie, this article that Harris mentioned is certainly right.

Mr. FAWELL. Individual companies set up corporate research laboratories. You talk to the director of a corporate research laboratory in an industrial company about his own or her own goals to transfer technology into the corporation itself, busy corporation,

and here we have institutions that are not members of corporations.

All I am trying to point out is that I really think we have come a long way with that and generated a lot of knowledge on how to do that, and the last thing I think we need to do is to pass some legislation that converts this whole laboratory system into what I think it cannot possibly be, a lab for corporate America.

Mrs. LLOYD. But, then, also, you are walking a fine line because when you start trying to do the work of the private sector, you must have real problems with the private sector.

Dr. SCHRIESHEIM. Private sectors know the market, and they know the commercialization, how to commercialize, should know how to commercialize. That is certainly not a charter. That is one that should be given to someone outside the commercial sector. I quite agree with that.

Mrs. LLOYD. Thank you.

Mr. Montgomery?

Mr. MONTGOMERY. Madam Chair, I totally concur with your observation about the Federal Government's role. My suggestion earlier was that as one example, you might consider converting the appropriation intended for the superconductor——

Mrs. LLOYD. We are going to be hearing a lot of that. We are going to hear a lot of that.

Mr. MONTGOMERY [continuing]. To the 50 states and my calculation would indicate that based on your preliminary budget figures, that would allow $100 million to each state if allocated equally to be matched, I would emphasize, by the states, thereby generating a $200 million impact initially, and we would further suggest that all of that funding be further matched by the private sector, and in one shot, we could be generating an impact on each of the states of some $500 million that we do not now have.

In Minnesota, we are the home of twenty Fortune 500 companies, including one of the most innovative in R&D, 3M. 3M spent last year about $800 million on research.

We believe that with our approach, working closely with the companies, such as 3M, enormous opportunity to commercialize many products which 3M at this point might not feel is a priority for them.

Mrs. LLOYD. Thank you very much.

Mr. Gage?

Dr. GAGE. I might just make one quick comment.

I have researched the subject that Egils was referring to in terms of the shift in federal R&D funding through the—from 1977 through 1987, for example, that time period, and the thing that should be underscored is in Egils' remarks, that we really were not so bad off here in mid-America in, say, the 1979-1980 period in terms of distribution of federal R&D funds.

But the major build-up in defense research and development and the de-emphasis on research and development in energy, environment, transportation, etc., meant a negative shift which was then super-imposed on the positive shift in defense, which ended up really removing our R&D base, our R&D funding base here in the Midwest to a very considerable degree, and if I make any observations, say, in a basis of a ten-year retrospective, it is that the Con-

gress probably ought to look deeper than just the budget numbers which come down to the bottom of the page and start and look in making these major investments at what kind of effects are going to have on the various parts of the country.

In a sense, we were—we lost a very strong competitive position in that 10-year period, and it is really a serious question about whether we will ever really be able to regain that, and that is strictly a function of the federal investment. It was not a function of what the state did.

Mrs. LLOYD. That is a very good point. It has been noted that after World War II, much of the defense powers were transferrable to the private sector. For instance, R&D money on nuclear engineering, but at the same time, we have not seen this type of transfer from the defense research and development dollars that we saw previously.

That is a very good point.

Mr. Miller?

Mr. MILLER. Madam Chair, having been a long-time resident of Anderson County, I can understand your remarks and your perspective on the role of the Federal Government in national labs.

If I can make an observation that has occurred in the membership of NCMS, we have more R&D programs than we can possibly fund. We have got better than $2 billion worth of potential options on the table right now, and what we have found is that our membership has come back and offered to support additional programs above and beyond their current due structure.

I think that that model, that partnership model, is applicable to things that are going on in the Federal Government right now, and the opportunities to take advantage of it are currently precluded under any of the Acts.

I believe that if we were able to strike the right partnerships, if we get down and we work out what the agreement has got to be, we provided the incentives in there for industry, the industry would come to the table, would be willing to send its people in the same way that you can go to Secouba Science City right now and walk in and out of every lab that is there and see people from the government, people from the industry and people from academia working on exactly the same programs. Not working on different ones on their own, just to use the equipment, but working on the exact same programs.

I think that you would find that U.S. industry would be willing to put money into those relationships and those programs.

Mrs. LLOYD. Very good.

Egils?

Mr. MILBERGS. I would like to pick up on that point, a very central point of my testimony. The national R&D priority situation over the past eight years was not relevant to the industrial adjustment problems of mid-America. I think that is a perspective that needs to be built into the thinking of the new science advisor as well as the Congress in its cross-cutting science and technology responsibilities.

How science and technology expenditures deal with the different problems in the region. We are a heterogenous country, and the needs are quite different as we look around.

Now, getting to the point of making the national laboratories corporate laboratories. Most certainly that was not the point of view I would take. The point of view that ought to be taken here is that the government should support and be involved when industry tries to address its competitive challenge.

Our laboratory system is one resource that can help bring solutions. I will assure you that industry's general attitude is not to get involved with federal laboratories for a whole host of reasons. Some of those reasons were addressed by the Federal Technology Transfer Act.

We need to focus on the question of how we utilize this national treasure of $17-18 billion in 700 federal laboratories and try to forge that partnership.

The research agenda, ought to be, to a large degree driven by the market and driven by industry, and the laboratory system be responsive and ready to work with industry.

When you go to Japan, one is always struck by the project teams they put together there. They have university researchers working right next to corporate researchers next to government laboratory people. They are working together, trying to do concurrent research, concurrent engineering and trying to go out there and win big. I think it is that type of direction we need to go as the different sectors get comfortable working together with each other.

Mrs. LLOYD. Who do you see as the unwilling partner? Industry or the Federal Government?

Mr. MILBERGS. Excuse me?

Mrs. LLOYD. In most cases, who do you see the unwilling partner? Industry or the Federal Government?

Mr. MILBERGS. I certainly think there has been enormous change in attitude within the federal laboratory system compared to 1980, when I first came into government to talk about joint ventures. Industry tech transfer was heresy in the system, and some of those same problems existed with universities with respect to the relationship with industry.

I think we have made a lot of progress. But now, so that we do not misallocate resources, we need to have industry step up to the plate and decide on some areas they want to address, that they are willing to put some of their own resources into it, and that is why the policy focus now is on industrial incentives to form these consortiums and make deals with the laboratory system. I think industry has got to get out there and start making a case. I am sure policy makers in Washington, who allocate R&D budgets would welcome informed industrial input. We need more of that kind of input.

The government's role should be to support not lead, and, no, we should not turn the laboratories strictly into being an R&D center for corporations. There are missions to be accomplished, but competitiveness and relevance to industrial needs is an important national need right now, and I believe the laboratory system has a role to play in that.

Mrs. LLOYD. Thank you.

Mr. Fawell?

Mr. FAWELL. I am going to, Madam Chairman, be brief. I know that time is of the essence here. We have a luncheon waiting and we have another panel.

But I am frustrated because there are so many questions I really have that you would like to put forth to the group, and I, first of all, do want to say thank you very much for taking your time to be here and to go over these points.

When you get done with a program like this and you feel as though you are just beginning to zero in now on the real issue that—which you may not have been fully aware of before.

Just several points I would like to make, though. That is that especially now with Mr. Montgomery here, the presentation regarding Minnesota, that was a very good one, and I enjoyed it very much. It was exceptionally well presented and it made me feel that the states are out there doing things and as Madam Chairman has brought out, the Federal Government just cannot do it all, and when we see, in fact, it is true in Illinois, also, with Wisconsin and Indiana, that whereas we should be doing more, I would agree with Egils that we ought to be aware of what the market is out there and how we can help the market drive.

It is awfully good to know that the states are not just a wasteland back home, they are doing things, they are adjusting, they are recognizing that, indeed, if we are going to boost our economy, we are going to have in many ways try to get those incentives to bring about the cooperativeness between the federal and academia and our research and do a much, much better job of transferring it.

I look forward to the business aspect of this and to get their reply to the question that I previously mentioned, and that is, how much of the problem is still business entities that still may not have awakened to the tremendous competition they do have. There is improvement. There is just no question about it as far as government and universities are concerned, as far as business people are concerned.

I can remember testimony at one of our hearings in Washington where I think it was, and I do not mean to potshot Rockwell, but I think Rockwell representatives testified that we have, Rockwell has, three representatives now in Tokyo, indeed, attempting to determine what is going on there in R&D and to read the publications and so forth and so on, and another witness testified that Mitsubishi has had four hundred representatives just in one New York office, which leads me to believe that that is just an example of how much perhaps Japan is so far ahead of us and our European competitors, also.

So, there is an awful lot, certainly, to be done, but at least I am aware that a lot is happening and that that cooperation that is so very, very vital, we can be number one as we are in basic research and still be number two or three or four in regard to applying that and implementing it and commercializing it and profiting in that sense.

But to a degree, I think, it is a change in the world, and there are a lot of nations now who are making advancements and that is basically good for everyone in this old world of ours. It seems to me that we cannot expect in this nation that we are always going to be number one in every scientific endeavor. It just is not—cannot be

and it will create more wealth, not redistribute wealth, but create more wealth for more people as more and more corporations and companies and countries are perfectly able to assimilate anything that our great minds, you know, create through breakthroughs and basic science.

I do not think you can be really competitive as a nation if you are not good at basic research, but, you know, some of the African nations are not going to be much of a competitor to this nation and this world.

But I will just leave those particular comments and a hundred other questions that otherwise I might have, and again say thank you very much for what you have presented.

All of this is being—will be transcribed, by the way, and we will have an opportunity to, along with our colleagues, to take a look at what we are saying.

Thank you again.

Mrs. LLOYD. Thank you.

Mr. Schiff?

Mr. SCHIFF. Madam Chair, I, too, will be brief. I have one question that I would like to bring up for whomever.

In my district is Sandia National Laboratory. Mr. Miller, Los Alamos National Laboratory is not in my district. It is actually up the hill, and those labs were founded around armaments reduction and that remains largely their major goal.

However, they both are moving in the direction of non-weapons research, such as we are concerned with here. They are concerned particularly about competing with the universities. They are afraid that if they go for grants in research and so forth, in the non-weapons area, that this will cause a great amount of friction with universities which have, generally speaking at least, not been in the weapons area, and I just wonder if, briefly, if it does not sound like it has been a problem.

These three speakers mentioned that there has been cooperation between the national laboratories and the universities in the Midwest. I just want to ask, is that—to stretch that out a bit. Is that a fact or has there been friction in terms of who has what turf kind of thing?

Dr. SCHRIESHEIM. I think we can look at a couple of examples. The approach really should be one—it is the one plus one equals three approach, if you do not mind that kind of an analogy. That is, where can the national laboratory and the universities cooperate, so that the—together, they are more than they are separately. Certainly, you are absolutely right in the sense that with the call on funding and the limited resource availability, there can certainly be rubs. There can certainly be friction.

So, one plus one equals three. What do I mean by that? Well, the superconductivity consortia that we put together in the state of Illinois is one that is clearly a one plus one equals three.

The parallel processing one that I mentioned that involves Argonne and Los Alamos and two universities, Rice and Cal Tech, is another one where, without these institutions working together, leveraging their resources with the National Science Foundation, not only would the national labs not have gotten funding, but the universities would not have gotten funding.

So, the world that we are moving into is sort of consortium-type of world. National labs, universities, national labs, universities, industries.

With respect to the weapons labs, if you will, certainly, there are lots and lots of opportunities to leverage the tremendous skills that exist within the labs in a fashion such that they work with the universities in a cooperative mode, in a mode so that it is a win-win situation.

But, you know, the real world we are living in, there has got to be some times when there is some same call on resources. It has worked, though, well, certainly worked well here. The Midwest, the bio-technology consortium that I mentioned earlier, the Muac the multi-phase flow, together with a bunch of universities. I think we have reached the situation here that the universities, if it is possible, would like to do programs with us jointly because, as I say, one plus one equals three, fifty percent of funding is better than a hundred percent of nothing, so to speak.

I hope that is useful.

Mr. MILBERGS. Let me just say federal policy has a big bearing on that cooperation. As I said earlier in my testimony, to the degree that NSF was promoting inter-disciplinary multi-institution types of proposals, there is a tremendous catalyst to bring people together.

We teamed up, for example, with Minnesota on the Hollings Center proposal with the theory that a multi-state proposal would do better. We ended up losing it, but, in any event, we have an opportunity next year maybe for the Hollings Center.

Secondly, I think in competing for federal and private funds, you cannot come in with third or fourth class capabilities. If you lack a certain technical skill, you have got to find it and team up with someone else so you can put together a proposal.

I think some of that parochialism, has certainly been around. However from the standpoint of economic reality and the direction of federal funding that we have seen, the kinds of things that we have talked about, has engendered the spirit of trying to work together.

So, I think it has been pretty positive.

Mr. SCHIFF. I just want to say that I like that one plus one equals three analogy. I want to say that since I am a lawyer, my time to the community does not expect better performance from me anyway, but I think I understand your point. I believe I can bring it to an understanding.

Thank you. Thank you, Madam Chairman.

Mrs. LLOYD. Thank you very much.

Thank you, gentlemen, for your outstanding testimony. We look forward to hearing from you again.

I apologize for running us over, but I think you have shared my enthusiasm for the excellent testimony which we have received.

We will break for lunch right now. We will be back this afternoon with a private sector panel.

This member will be touring the laboratory this afternoon, but I am certain that the hearing will go on quite well without my participation.

So, at this time, I do want to thank all of you for making this possible. I want to thank the laboratory for the hospitality and its getting this room, but the preparation for the hearing. I want to thank the press for your participation, and I would also like to recognize Carl Bretscher who is with us, from Mr. Fawell's staff, in addition to the staff from the Science and Technology Committee.

If there is no further business, the committee stands in recess for 1 hour.

[Recess.]

AFTERNOON SESSION

Mr. STALLINGS [presiding]. Ladies and gentlemen, it is time that we get underway.

We missed Mr. Knuepfer. Am I saying that right? During the morning session, and, so, we will have you be our lead-off this afternoon.

Gentlemen, if we could suggest that we keep the statements within about a ten-minute time frame, so it will give us the time to ask questions, and I believe you have an event taking place about four this afternoon. You are touring, is that what I am understanding?

Mr. FAWELL. Yes.

Mr. STALLINGS. So, we will try and keep that within that timeframe.

Mr. Knuepfer, you are the Chairman of the DuPage County Board. We welcome you here before this committee and look forward to your testimony.

STATEMENT OF JACK T. KNUEPFER, CHAIRMAN, DUPAGE COUNTY BOARD

Mr. KNUEPFER. Thank you.

I can tell you I am delighted to be here. I am thankful that those of you outside of this constituency have given of your time to be here to listen to our concerns.

I want to recognize, I think, first of all, that the men and women that we elect to Congress are continually subjected to an inordinate amount of pressure, competing for the limited resources of our society, and I think that has to be out front.

There will always be a need and you have the difficult job of determining how to allocate the limited resources of our society. Education, the defense of our country, human needs are dominant as contenders for our resources. That you know.

With this backdrop, I think we need to look at America from a half century perspective. Just 50 years ago, we were the dominant industrial force of the world. Our factories made goods for all the world. Our farms produced the grains to feed many outside of our country.

Today, we have lost a good deal of that industrial dominance, and our farm products have been effectively restricted from many of the world's markets. Although we have managed to improve our defense posture, in many respects, Americans have not been willing to pay for it. We have financed some of that defense simply by borrowing overseas.

Ultimately, however, the strength of America is in her productivity. Human needs, the defense of our country, education are all financed by our production systems. We do not choose to compete, however, head on with wages paid by Koreans, Taiwanese or South American labor.

The only alternative then is to continue to surpass these nations in productivity gains. We are not alone anymore however. Japan, European countries, expend very substantial sums in research in fields such as machine tools, cameras, and electronics, and have surpassed us in all of these areas.

Here in DuPage County, research is an important component of our lifestyle. Argonne and Fermi National Laboratories are, of course, our two premiere governmentally-funded institutions. But we have many more in the private sector.

Chicago area is the home to three institutions of higher learning, world class institutions. University of Illinois, University of Chicago, Northwestern University.

Our goal in DuPage, and we are not asking for help from the Congress for this, is to put together, to complement this high-tech corridor, the Graduate School of Math, Science and Engineering, to provide the academic nurture for the research institutions of both this county and of the corridor.

Probably the greatest single productivity increase in the past quarter center has been the computer. It has spawned an information age almost beyond comprehension. You in Congress have recognized America's pre-eminence in this field by creating Semetech, a research consortium to help America become more competitive.

The Institute of Machine Tools, if that is the appropriate name, is another one that the Congress has recognized as an industry of particular importance.

Basic research of twenty years ago is the field for application engineering today. We want to encourage the Federal Government's continued support of basic research as the core of our research efforts, but in specific technologies, application research may be appropriate.

Unlike the speaker of this morning, I think I would prefer to recognize that the role of the government is probably more important in the area of basic research and as much as possible we should count on the private sector for the application research.

We encourage the Federal Government's continued support of this. We encourage continued efforts to provide technology transfer at a more rapid rate than at present, and it is not always easy. Much of our business growth these days is small business, and the men and women who run small business operations are harder to reach because they are very busy people. That does not say impossible to reach, just more difficult.

The projection of America's power in the world, which is our defense establishment, the health and welfare of our citizens, and the opportunity for a good education, all ride on the back of a productive America. It will be the scientific discoveries of today that provide our living some twenty years hence.

DuPage County and the State of Illinois have a role to play. We hope that you in the Congress will continue to recognize the impor-

tance of research, yes, basic research as a goal for maintaining the kind of America that we consider the one we want to live in.

Thank you.

[The prepared statement of Mr. Knuepfer follows:]

TESTIMONY

BEFORE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

Jack T. Knuepfer, Chairman

DuPage County Board

February 10, 1989

We want to recognize first of all that the men and women we elect to the Congress are continuously subjected to an inordinate amount of pressure by groups competing for the limited resources of our society. There will always be need and you have the difficult job of determining how to allocate limited resources. Education, the defense of our country, and human needs are dominant as contenders for our resources.

With that backdrop, we need to look at America from a half-century perspective. Just 50 years ago we were the dominant industrial force in the world. Our factories made goods for all of the world. Our farms produced the grains to feed many outside of our country.

Today, we have lost a good deal of our industrial dominance and our farm products have been effectively restricted from many of the world's markets. Although we have managed to improve our defense posture, Americans have not been willing to pay for it and we have financed our defense by borrowing overseas.

Ultimately, the strength of America is in her productivity. Human needs, the defense of our country, as well as education are all financed by our production systems. But, we do not choose to compete head on with the wages paid to Korean, Taiwanese or South American labor.

Our only alternative, then, is to continue to surpass these nations in productivity gains, and research is an avenue in which we have excelled. We are not alone, however. Japan and Europe expend substantial sums in research in fields such as machine tools, cameras and electronics and have surpassed us in these areas.

Here in DuPage County research is an important component of our lifestyle. Argonne and Fermi National Laboratories are, of course, our two premier, governmentally-funded institutions, but we have many more in the private sector. The Chicago area is the home of three world-class institutions of higher learning: the University of Illinois, the University of Chicago and Northwestern University. However, our goal is to put in place a graduate school of math, science and engineering to provide the academic nurture for the research institutions of the county.

Probably the greatest single productivity increase in the past quarter century has been the computer. It has spawned an information age almost beyond comprehension. You in the Congress have recognized America's pre-eminence in this field by creating Sematech, a research consortium to help America become more competitive. Basic research of twenty years ago is the field for application engineering today.

We encourage the federal government's continued support of basic research as the core of our research efforts, but in specific technologies application research is appropriate. We encourage continued efforts to provide technology transfer at a more rapid rate than at present. Much of our business growth these days is in small business and the men and women who run these operations are harder to reach because they are very busy people.

The projections of America's power in the world, the health and welfare of our citizens and the opportunity for a good education all ride on the back of a productive America. It will be the scientific discoveries of today that provide our standard of living some twenty years hence.

JTK:oc
2/10/89

Mr. STALLINGS. Thank you, Mr. Knuepfer.

I think it would be appropriate to go to the rest of the witnesses and give them each a chance at this point, and then we will come back and open it up for questions.

Our next witness, Mr. Ormand J. Wade, President of Ameritech-Bell Group.

Welcome, Mr. Wade. If you would care to proceed.

STATEMENT OF ORMAND J. WADE, PRESIDENT, AMERITECH-BELL GROUP

Mr. WADE. Thank you, Mr. Chairman.

My name is Ormand J. Wade. I am President of the Ameritech-Bell Group, which is comprised of the Bell Companies of Illinois, Indiana, Michigan, Ohio and Wisconsin, as well as related support companies.

I am testifying in my capacity as Chairman of the Joint Task Force of the Information Industry Council of Metropolitan Chicago, and the Institute for Illinois.

This Task Force was formed specifically to address the issue and the question of corporativity in the service sector, and that is my topic for today.

Ameritech is itself a major service sector company with some $19 billion in assets and 77,000 employees. We are dedicated to delivering telephone and other telecommunications-related services to our customers in the upper Midwest.

Because of this, our company has special competence in matters relating to information technologies, information systems, and productivity in the delivery of such services.

In addition, the nature of our business acquaints us in depth with the major companies, the educational facilities, the information industry resources, and the other capabilities that are characteristic of this region.

The service sector is enormously important to the American economy as was pointed out earlier today. At the end of 1987, it accounted for more than two-thirds of the gross national product and three-quarters of the national employment.

Despite the large and growing importance of the service sector, productivity improvement has been relatively flat as compared to manufacturing, which has seen consistent and significant productivity gains during the 1980s.

Clearly, lagging productivity in the service sector of the U.S. constitutes a serious threat to American leadership and our ability to compete in this essential sector of the world marketplace.

Today, I will address what I see as three causes of poor service sector productivity and then outline some specific steps toward a solution.

One cause of low productivity gains is uncoordinated applications of information technology within and between companies. The service sector has invested heavily in information technology. Why has this investment not paid off in productivity gains?

Typically, different departments, different organizations within a company have picked the information equipment and the system designs which really has been based upon what kind of efficiency

gains might occur in that part of the operation with little or no vision of the impact of their decisions on the effectiveness of the whole.

In effect, they have created islands of technology with no bridges and sometimes the result was less order and less synchronicity in the overall operation than before.

The second cause of poor productivity gains in the service sector is that there has been virtually no research and development investment by the Federal Government in service sector productivity.

The third cause also relates to government decisions. Although telecommunications is at the core of information technology and service sector productivity, development of the telecommunications industry in this country has been severely hampered by government policy or, perhaps I should say, lack of policy.

An illustration of this is the restrictions imposed at the time of the break-up of the Bell System which are currently being kept in place by the U.S. District Court in Washington, D.C.

The restriction against manufacturing, for example, delays the deployment of technology in the public telecommunications network. It stifles telecommunications research and development. If this restriction were lifted, we could begin to work with companies whose technology might be better than that of our current suppliers, and we could bring more sophisticated products to the network and to the marketplace.

The restriction against full participation in the provision of information services has had the effect of withholding these productivity-enhancing services from the small business sector, where, today, most of our economic growth is, in fact, taking place and most jobs are being created.

In many ways, it is astonishing that a policy decision of this magnitude could be allowed to be made in the Federal District Court. I was pleased to see that in the last weeks of the 100th Congress, House Concurrent Resolution 339 gained 205 votes in support of the proposition that Congress should act to remove the restrictions from the jurisdiction of the court.

While the restraints on service sector productivity growth are, indeed, serious, the ways to eliminate them are neither complicated nor out of reach. The first is to increase federal spending for research and development on service sector productivity.

The Task Force that I head is convinced that the core issue is the transfer of knowledge and technology. More specifically, we believe federal R&D dollars should be spent answering the question, how can information technology be brought to and applied in the service sector in a way that addresses overall effectiveness and not merely particular efficiencies?

To make this technology transfer possible, it is necessary to bring available and emerging technologies into an environment where applications to the needs of the service sector can be studied and can be tested.

It is our contention that federal R&D monies dedicated to service sector productivity should be used to seed consortiums which, in turn, would establish centers of competence to conduct these studies and tests.

The consortiums would include federal and perhaps state agencies as well as academics, but the most active participants would be service sector users of information technology and information technology suppliers.

We believe that there is enough private sector support for this idea that private sector commitments could be made prior to federal commitments, rather than depending on federal action first.

We further believe that while all partners in the consortium should have a voice in establishing the directions for these centers of competence, the needs and the priorities of technology users in the service sector should really drive the process.

The most logical site for a pilot of service sector productivity is in the Midwest and, more specifically, in the Chicago metropolitan area.

First of all, there is in the Chicago area a high concentration of service industries. These are the users of information technology and the beneficiaries of service sector productivity increases that we see.

In insurance, we have CNA, Kemper, Allstate, Signa, First Chicago and Continental Illinois. Of course, major banks. In the financial services area, we have the Chicago Mercantile Exchange, the Chicago Board of Trade, the Chicago Board Options Exchange. In health care, we have got Michael Reese, the University of Chicago Hospital, Rush Presbyterian, St. Luke's, Northwestern Memorial Hospital, Loyola and others.

In merchandising, we have Sears, Marshall Fields, Montgomery Ward. We also have in the Midwest, more specifically in the Chicago area, the expertise and the facilities to support studies of service sector productivity.

According to Datamation, there are more computer sites in the five states of the Ameritech region than any of the areas served by the other six regional companies formed at the time of the Bell system break-up.

The Chicago area also is home to a number of information industry companies. My company, of course, is headquartered here as is Centel. We have Bell and Howell, Chicago Tribune, an extensive AT&T presence, Motorola, Zenith, and a host of smaller companies.

There are excellent super-computer facilities, both here at Argonne, and at the University of Illinois, and, of course, there are major universities, as has been cited before.

In short, there are in this area as in no other area both the will and the wherewithal to make a contribution to the cause of service sector productivity which will be of national significant and of national value.

The second action to build service sector productivity is even simpler than the first, and unlike the first, it requires no expenditure of tax dollars, and it is to lift the restrictions and the regulatory restraints impeding the full development of the telecommunications industry.

The urgency of the task is clear. This nation's productivity in the service industries must be improved dramatically or we face economic loss both at home and in the global marketplace.

It is also clear that the Federal Government in the form of the United States Congress is in a position to make the necessary

changes. All of the remedies I have described should be enacted by the current Congress.

I hope the seriousness of the situation will be understood and the necessary steps will, in fact, be taken. If we wait, we lose.

Thank you.

[The prepared statement of Mr. Wade follows:]

Testimony of Ormand J. Wade
President-Ameritech Bell Group
before the
House Subcommittee on Energy Research and Development
Naperville, Illinois
February 10, 1989

My name is Ormand J. Wade. I am president of the Ameritech Bell Group, which is comprised of the Bell companies in Illinois, Indiana, Michigan, Ohio and Wisconsin, as well as related telecommunications companies.

I am testifying in my capacity as chairman of a Joint Task Force of the Information Industry Council of Metropolitan Chicago and the Institute for Illinois. This task force was formed specifically to address the matter of productivity in the service sector, and that is my topic today.

Ameritech is itself a major service sector company. With some $19 billion in assets and 77,000 employees, we are dedicated to delivering telephone and other telecommunications-related services to our customers in the upper Midwest. Because of this, our company has special competence in matters of information technologies, information systems, and productivity in the delivery of service. In addition, the nature of our business acquaints us in depth with the major companies, the educational facilities, the information industry resources, and the other capabilities characteristic of this region.

I. THE SERVICE SECTOR AND PRODUCTIVITY

The service sector includes all government and educational institutions, and all businesses which are not "goods producing," i.e., all businesses except manufacturing, agriculture, mining and construction.

This is an enormously important area: according to the Department of Commerce, the service sector at the end of 1987 accounted for more than two-thirds of the Gross National Product and three-quarters of national employment.

According to a 1988 report by the Hudson Institute, "Workforce 2000," manufacturing employment will continue to decline through the remainder of the century, while service sector employment will continue to increase.

Despite the large and growing importance of the service sector, productivity improvement in this sector has been relatively flat, as compared to manufacturing, which has seen consistent and significant productivity gains during the '80s. Data published in Fortune, August 1, 1988 show that during the period from 1977 to 1987, manufacturing productivity increased about 35 percent, while productivity in the service sector improved by less than five percent.

The Hudson Institute report summarizes the issue on the table today: "Manufacturing still controls the imagination, the statistics, and the policies of the nation, even though it now represents a small and shrinking fraction of national employment and output. The nation's mental image of progress continues to be one in which manufacturing plants produce more cars, computers and carpets per hour. But services are a far larger segment of the economy ... These industries ... must be the target of government efforts to improve productivity."

Clearly, lagging productivity in the service sector of the United States constitutes a serious threat to American leadership and our ability to compete in this essential sector of the world marketplace.

The parallel with the American experience in manufacturing is clear: Lower labor costs in foreign countries was only one reason for the loss of United States leadership in manufacturing. The other reason, and no small one, was our failure to increase manufacturing productivity.

We would be foolish indeed to squander our strength in the service sector through similar inaction.

In what follows, I will address what I see as three causes of poor service sector productivity in this country, and then outline some specific steps towards a solution.

II. CAUSES OF POOR PRODUCTIVITY IN THE SERVICE SECTOR

A. One cause of low productivity gains is uncoordinated applications of information technology within and between companies.

The service sector has invested heavily in information technology. According to Harry L. Freeman, Executive Vice President, American Express Company, per-capita high technology investment in the service sector now exceeds that in the manufacturing sector. Why has this investment not paid off in productivity gains?

Partly this has been due to internal mismanagement. Typically, different departments and offices in a company picked information equipment and system designs on the basis of what would increase the efficiency of their part of the operation, with little or no vision of the impact of their decisions on the effectiveness of the whole. In effect, they created "islands of technology," with no bridges, and sometimes the result was less order and synchronicity in the overall operation than before.

Information technology investments by companies which wanted to improve their ability to do business with other companies have often had a similar unhappy outcome, and for the same reason -- no coordination of technologies into a coherent system.

Disjointed application of technology has also been caused by a multi-vendor environment and an absence of common industry standards for interconnectivity.

Uncoordinated applications of information technology might have been avoided had there been more research on how to gain productivity through the use of information technology, i.e., had there been more focus on standards, and more study of how to plan, manage, and implement applications.

B. This leads to the second cause of poor productivity gains in the service sector: Surprisingly enough, there has been virtually no R&D investment by the federal government in service sector productivity. This was the conclusion of a paper by James Brian Quinn of Dartmouth College delivered at the National Academy of Engineering in February, 1988. R&D on productivity seems always to imply R&D on manufacturing productivity.

This is not to denigrate the importance of the manufacturing sector. But the importance of the service sector to American employment, the American economy, and American competitiveness in the world marketplace is such that it should not be ignored, as it presently is, in the allocation of federal R&D dollars.

C. The third cause of low productivity gains in the service sector also relates to government decisions. Although telecommunications is at the core of information technology and service sector productivity, development of the telecommunications industry in this country has been severely hampered by government policy, or lack of policy.

In this context, the words of William L. Weiss, Chairman and Chief Executive Officer of Ameritech, are appropriate:

"...there has been a restructuring of the world's economy around information. Rapid information transfer has become the coin of the global marketplace.

"To see this, we need only look at our own country, where some 55 percent of retail sales are completed over the telephone. In fact, try to imagine any serious and economically significant business activity being conducted today without reliance on telecommunications.

"On the international scene, information technology is often the measure of a nation's ability to act -- for example, in world financial markets, where time zones are disappearing and major markets are moving to a 24-hour day...

"So as our leaders struggle to improve our international competitiveness, they must also deal with the telecommunications network as one of this country's most important economic resources.

"...the curious fact is that many other nations have acted in response to the information economy -- and the United States has not. ...Indeed, such policies as we do have act as a brake on the development of American information capabilities." [Address to the Economic Club of Detroit, November 14, 1988]

I will cite two examples to show that government policy is indeed a severe constraint on the development of telecommunications capabilities, and therefore on the growth of service sector productivity.

1) The first case is the restrictions preventing manufacturing and the provision of a full array of information services by the Bell companies. These restrictions were imposed at the time of the breakup of the Bell system, and are currently kept in place by the U.S. District Court in Washington, D.C.

The restriction against manufacturing delays the deployment of technology in the public telecommunications network. For example, we could not get off-the-shelf capability from AT&T to connect Local Area Networks through our central offices; AT&T provides it through their on-premises product line. Because we are prohibited from developing this capability ourselves, we have had to go through a time-consuming process of patching it together with the use of adjunct equipment from another supplier.

The manufacturing restriction also stifles telecommunications research and development. It prevents major parts of the American telecommunications industry from engaging in R&D on communications hardware, and on software related to that hardware. It even prohibits working with other companies on R&D if the output is to be a product that the Bell companies could use.

If this restriction were lifted, we could begin to work with companies whose technology might be better than that of our current suppliers, and we could bring more sophisticated products to the network and to the marketplace.

The restriction against full participation in the provision of information services has had the effect of withholding these productivity-enhancing services from the small business sector, where today most of our economic growth takes place.

There are thousands of information services available in France. Japan, Germany, the United Kingdom, and Canada are among other countries which now offer information services through their public telecommunications networks.

Information services for the small businesses of these countries include voice messaging (the equivalent of an answering service), access to information data bases, industrial comparison shopping, transaction entry, financial planning services, spreadsheet analysis, budget planning and many others. These services can be accessed without an expensive computer or software, and are a tremendous boost to efficiency and bottom-line profitability.

Thus the information services restriction, like the manufacturing restriction, is preventing applications of information technology that would greatly enhance service sector productivity.

It is astonishing that policy decisions of this magnitude are allowed to be made in a federal district court. I was pleased to see that in the last weeks of the 100th Congress, House Concurrent Resolution 339 gained 205 votes in support of the proposition that Congress should act to remove the restrictions from the jurisdiction of the court. The reasons listed in that resolution were the same as I cite today: the restrictions are creating unnecessary and extensive damage to the American economy and to American competitiveness in international markets.

2) The second instance of government policy restraining the development of telecommunications is that form of regulation imposed at both the federal and state level called rate-of-return regulation. Essentially, this is the practice of regulating the earnings of the telecommunications companies instead of their prices. It discourages a level of participation by investors that would make possible the creation of a telecommunications network in this country similar to those already being implemented in other countries.

In most countries, the basic telecommunications network is under the control of the government. The government can simply decide to invest in new technologies. In this country, the network is privately owned and is a creature of the free enterprise system. In principle, this should allow us to move ahead with even more efficiency than other countries. But instead, government policies are getting in the way. Our country in this case is not allowing what is inherently a superior economic system to do its work.

III. HOW TO IMPROVE SERVICE SECTOR PRODUCTIVITY

While the restraints on service sector productivity growth are indeed serious, the ways to eliminate them are neither complicated nor out of reach.

A. The first is to increase federal spending for research and development on service sector productivity.

The Task Force on Service Sector Productivity is convinced that the core issue in service sector productivity is the transfer of knowledge and technology.

More specifically, we believe federal R&D dollars should be spent answering the question: How can information technology be brought to and applied in the service sector in a way that addresses overall effectiveness and not merely particular efficiencies?

1) To make this technology transfer possible, it is necessary to bring available and emerging technologies into an environment where applications to the needs of the service sector can be studied and tested.

It is our contention that federal R&D monies dedicated to service sector productivity should be used to seed consortiums which in turn would establish centers of competence to conduct these studies and tests.

The consortiums would include federal and perhaps state agencies, as well as academics; but the most active participants would be service sector users of information technology and information technology suppliers, who would use the laboratory setting to develop practical applications of technology to the solution of business problems.

There would be some formula for supplementing the federal investment in these centers of competence with investments by the business community, and perhaps universities and state governments as well. We believe that there is enough private sector support for this idea that private sector commitments could be made prior to federal commitments, rather than depending on federal action.

We further believe that, while all partners in the consortium should have a voice in establishing directions for these centers of competence, the needs and priorities of technology users in the service sector should drive the process.

2) In dealing with the issue of technology transfer, special attention needs to be given to the development of applications for ISDN -- Integrated Services Digital Network.

ISDN is a network that provides end-to-end digital transmission, and thus supports a wide range or services including voice, data and video.

ISDN is particularly promising as an instrument for productivity growth in the service sector because it helps coordinate and integrate different departments within companies -- and different companies -- into coherent, effective information systems.

We believe that applications for ISDN can be found in almost every facet of a service sector business. The paradox, however, is that the existence of multiple applications is needed to drive the deployment of ISDN, yet multiple applications cannot be found and tested if there is no ISDN facility in which to experiment.

Recently, the National Institute of Standards and Technology (NIST) proposed the establishment of a number of ISDN centers throughout the country. These centers would provide precisely that laboratory setting which is necessary to experiment with, develop, and test ISDN applications.

We thoroughly support this initiative. Not only does it address an important productivity need, it also will help the United States keep up with developments in Europe. In Europe, a group of 230 organizations and companies has come together to define an economic infrastructure based on greater bandwidth to integrate different telecommunications services into a common network. This group is called RACE -- Research and Development in Advanced Communications in Europe. The approximately $.5 billion a year they will spend on research will include funding for ISDN centers.

It is possible that NIST might be the appropriate agency through which to channel federal funds for one or more service sector productivity centers as well as for the ISDN centers.

3) The most logical site for a pilot service sector productivity center, as well as for an ISDN center, is the Midwest, and more specifically, the Chicago metropolitan area.

First of all, there is in the Chicago area a high concentration of service industries. These are the users of information technology and the beneficiaries of the service sector productivity increases we seek. In insurance, we have CNA, Kemper, Allstate, Signa. First Chicago and Continental Illinois are major barks. In financial services we have the Chicago Mercantile Exchange, the Chicago Board of Trade, and the Chicago Board Options Exchange. In health care, we have the Michael Reese Center, the University of Chicago Hospitals, the Rush-Presbyterian St. Luke complex, Northwestern Memorial Hospital, and the Loyola Medical Center. In merchandising, there are Sears, Marshall Fields, Montgomery Ward.

We also have in the Midwest, and more specifically in the Chicago area, the expertise and the facilities to support studies of service sector productivity.

According to Datamation, there are more computer sites in the five states of the Ameritech region than in any of the areas served by the other six regional companies formed at the time of the Bell system breakup.

The Chicago area also is home to a number of information industry companies. Ameritech, of course, is headquartered here, as is Centel. We have Bell & Howell, the Chicago Tribune, an extensive AT&T presence, Motorola and Zenith.

There are excellent supercomputer facilities both at the Argonne National Accelerator Laboratory and at the University of Illinois.

And, of course, there are the major universities -- the University of Illinois, the University of Chicago, Northwestern University, the Illinois Institute of Technology, De Paul University, and Loyola University.

In short, there are in this area -- as in no other area -- both the will and the wherewithal to make a contribution to the cause of service sector productivity which will be of national significance and of national value.

B. The second action to build service sector productivity is even simpler than the first, and, unlike the first, it requires no expenditure of tax dollars. It is to <u>lift the restrictions and regulatory restraints impeding the full development of the telecommunications industry</u>.

IV. THE ROLE OF CONGRESS

The urgency of the task is clear: this nation's productivity in the service industries must be improved dramatically or we face economic loss both at home and in the global marketplace.

It is also clear that the federal government in the form of the United States Congress is in a position to make the necessary changes.

All of the remedies I have described could be enacted by the current Congress. I hope the seriousness of the situation will be understood and the necessary steps will be taken.

If we wait, we lose.

Mr. STALLINGS. Thank you, Mr. Wade.

Our next witness is Dr. Bill Hunsinger, President, Electronic Decisions, Inc.

Dr. Hunsinger, we welcome you and look forward to your testimony.

STATEMENT OF DR. BILL J. HUNSINGER, PRESIDENT, ELECTRONICS DECISIONS, INC.

Dr. HUNSINGER. I am going to depart from my prepared testimony. I would like to have you just put that into the record.

I am departing on purpose because after listening to all of the experts in this field, I realize that I am very much a specialized individual and probably can give a kind of a worm's eye view of the technology transfer situation.

I thought possibly the one area that I know about, I could explain in a little bit more detail, and I am not trying to propose anything that is a universal solution, but is a possible solution.

I would like to first identify three problems that we have run into and then talk about three solutions.

First thing, my background. I spent twelve years in industry in Magnavox and General Electric, trying to bring technology out of industrial R&D labs into industrial products. That is a very interesting and difficult effort in itself.

I also was a liaison to the University of Illinois and I tried to work with the University to extract technology out of the University into the business base of Magnavox, and that was even a more interesting experience.

Basically, there is an incompatibility that tends to arise between the research community and the users of the technology that must be bridged or we must not be surprised that technology does not get transferred.

Basically, I decided then that I wanted to do research and actually see something transferred. So, I joined the staff of the University of Illinois. Now, this is not a national laboratory, but it is a rather distinguished research institution, and I had this particular goal that I was after.

The goal that I was trying to do and you get a technologist here, you are likely to get a fifteen minute lecture on technology, but I promise not to do that. Basically, what I wanted to do is to make a radar or communication receiver that was software programmable so that it could do the communications and radar area what microprocessors did to control systems, so that you could use the same part for a lot of different applications, for radar systems, surveillance, communications, navigation, radio phones, these different things. They would all be the same, and, therefore, you could increase productivity, and that was kind of a pipe dream, and, so, I wrote proposals trying to get the technology to be developed under NSF funding.

N.S.F. came back and said that is applications research. We think, Bill, we think your work is very good, but, really, we have such a few dollars for fundamental research as was pointed out a few moments ago, we cannot share that for applications.

So, then, you turn to the other side of the financing community and you say, okay, venture capitalists, how would you like to fund this development. Well, how much money is it going to take? $50 million. When is it going to reach the market? Well, in its elementary form, it will reach the market in five years, and it will really start making a profit in ten.

Now, what kind of response are you going to get from any sensible venture capitalist? And, so, there is a hole between our mechanisms for funding this research and, so, the research is sitting in the laboratories unused because the researcher, in general, and I am sure I am speaking to many of them in this room, we really get our enjoyment from publishing papers and getting the notoriety. That is what we are after.

And, so, therefore, there is a real gulf that one has to overcome if you want to exploit this technology and so the technologies are laying unused in many cases.

Well, I finally did make somewhat of a breakthrough, and, so, it became obvious that I had the basic engine for doing what I wanted to do, and I went around to the major corporations and tried to get them to support it.

Meanwhile, we had many visitors that were not from this country, that were hounding our doors, and we could not get audiences with major American corporations, and it makes sense because the story that I had to tell was not attractive to them. Too much risk, too long a delay, and, therefore, not a good risk reward ratio.

So, this is not what I am offering as a potential solution, is not a panacea. It is not going to solve all the world's problems and transfer all the technology out of laboratories, but I think it is a way that has a possibility of working. It has worked for us.

If I can take just a couple of minutes and tell you what we did do.

Knowing that it was absolutely impossible to get this kind of capital together, we formulated a strategy whereby we would develop this, particular devices, not the ultimate, but the particular devices, for the Department of Defense, and they found that they could use it.

Since this is a semi-conductor technology and it required us to have a foundry and probably around—we presently have about $12 to $14 million worth of equipment in our foundry, we were going to finance the capital with private funds.

But, again, even with the government contracts, that was not possible, and, so, what we did is work together with the University of Illinois and we rented equipment. We found junk in their basement, fixed it up, and then rented from them. We had, during the period of this time, acquired approximately $30 million worth of research and development funds to develop this technology.

We are approximately six months ahead of schedule in delivering our first products. We have brought around $300,000 worth of R&D funds to the university. The university has an INM planter that was a piece of junk that we now rent, fixed up and rent and pay them rent for using it, and, meanwhile, it has saved, and this is one of the examples, it has saved us millions of dollars.

The problem is these kinds of cooperations can work, because there are facilities in your laboratories. If you were to go out in

this organization, there are facilities that are under-used, and with a little bit of creativity, they could be multi-tasked, but do not expect a researcher who is primarily interested in doing fundamental research to go through all the political hassle that you have to do to get these government contracts and all the agreements and the rights issues and all of those kinds of things coordinated. That is just not what they are used to doing.

So, there have to be, I believe, an inducement to start technology transfer small businesses. These would be small businesses that would have to share the risk, but their job and they would be chosen on the track records and they would be chosen on their willingness to risk and bet on their own capability to go into the laboratories, seek out the things that are useful in the laboratory, identify the markets where they could be used, pull them together, formulate the team and the finances, and they would get their repayment when it wins, and I think that can be done if the rights issues are handled and if the tax incentives and possibly insured grants were to make it so that the risk reward ratio would be a little bit reasonable.

I can go on for quite some time. I have already gone three minutes over. I am sorry. But I believe this is one way to get additional value out of the millions of dollars that we have, in fact, invested in fundamental research.

Thank you.

[The prepared statement of Dr. Hunsinger follows:]

STATEMENT OF: Dr. Bill J. Hunsinger
President, Electronic Decisions Incorporated
Urbana, Illinois

SUBMITTED TO: House Committee on Science, Space and Technology
Subcommittee on Energy Research and Development

FOR: The Hearings on Mid-America Science and Technology
Perspectives and Priorities

Argonne National Laboratory

February 10, 1989

Background

I wish to express my thanks to the Chairperson and to the members of this Subcommittee for affording me the opportunity to express my personal views on the subject of technology transfer. It is a broad and complex subject and one which has extreme importance not only for the economic vitality of the Midwest but for the competitive position of the United States in a growing but increasingly difficult world market economy. The views and opinions which are contained in this statement are my own and do not represent a policy position of any organization or group.

Because the broad range of topics and issues which this hearing seeks to address goes far beyond my personal experience or expertise, I have chosen to limit my remarks to one narrow theme. Technology transfer is presently being impeded by public policies, R&D laboratory attitudes and by the absence of effective companies specializing in technology transfer.

I have seen and been involved in the technology transfer issue from three distinct perspectives over the past quarter century. Early in my career, as an electrical engineer in research and development, I worked in a large corporation and had occasion to be involved with industry-university liaison. Later, I held a faculty position in a research laboratory of a large public academic research institution and undertook a variety of research

tasks under Federal Government sponsorship. Most recently, I have been involved in the R&D field as a small businessman trying to create commercial value from a publicly developed research technology. Based upon this involvement in several facets of the R&D and technology transfer processes, I have made a number of observations and formulated some conclusions which I would like to offer for consideration by this Subcommittee.

What Are Some of the Problems?

1. Roadblocks exist which prevent or inhibit businesses from being willing or able to seek out and invest in new technologies. The perceived slow return and high risk discourage many traditional investors. The level of funding required and the time it takes to achieve an economic benefit from research and development are both significant. This is especially true of the emerging technologies which will be key building blocks in tomorrow's markets in such fields as, for example, microelectronics, supercomputers, superconductivity and biotechnology. These are essentially capital intensive activities and they require very specialized skills and training for their conduct. It may take a long time to get a new development in these fields from the research laboratory to the market, and a company must perceive a proprietary advantage from its investment in R&D in order to be motivated to undertake the risk of the investment. At the present time the policies surrounding collaborative or cooperative

research activities between private companies and federal or other public research organizations are such that, unless the entire cost of such research is borne by the company, the rights to the research results will be made available to all competitors. In fact, the policies in place at many academic research institutions prohibit the undertaking of proprietary research for or with a private corporate sponsor or partner irrespective of the source of funding for the work. Exclusive licensing of public research is an exceptional and infrequent occurrence.

In many cases the continued research and development on a topic is best and most efficiently done by its original developer or inventor. If this individual is in a federal or public research laboratory it is difficult if not impossible for that person to contribute to, lead or be involved in any aspect of its refinement or further development if there is to be a proprietary position resulting for a private company.

2. Laboratory attitudes and organization are not conducive to technology transfer. It is often difficult for a private company to sift through the research projects and activities in a variety of technologies being pursued at these laboratories in order to find something that fits its needs and goals. Part of what contributes to this difficulty is the sheer bulk of projects being undertaken. But equally important in many cases is the disparity in orientation between the personnel at the laboratories

and those in private business. While extensive listings and compilations of federally and publicly funded research activities are made available, there are few if any of these laboratories which have people on their staffs whose main job is to facilitate and encourage successful technology transfer. The recently enacted Federal Technology Transfer Act acknowledges the need and is a first step in the right direction but it is by no means the solution to this problem.

Traditional attitudes in laboratories inhibit aggressive technology transfer. With the exception of the opportunity to consult researchers have little if any motivation to transfer their technologies. There are, in fact, many professional disadvantages that may accompany the transfer of their technology to industry. If proprietary positions are given to private businesses the researcher may find that his future ability to publish on that technology may be restricted. Researchers typically enjoy some subject matter freedom and lack of schedule pressures. Efforts to transfer technology may compromise that. Researchers also tend to strive for and be driven by the goal of perfection, and a pragmatic approach to R&D is often not welcomed in such an environment.

3. Large companies cannot be relied upon to take the lead to carry out technology transfer. Under the present system large American companies generally feel that the risks and costs far

outweigh the near-term benefits of developing longer term technologies. In my own case I could not generate any domestic corporate interest in a new microelectronics technology while I was a laboratory researcher. The Japanese, however, were constantly at my doorstep and aggressively seeking ways to exploit and commercialize it. While I do not profess to be able to accurately explain this apparent dichotomy, it seems to me that it arises from the different planning and patience horizons of large American companies and their Japanese counterparts. While the Japanese seem willing to wait for the benefits of a new technology to begin to show up in financial statements, American businessmen in large publicly traded corporations focus on short-term results that will impact their next quarterly or annual report and thus are not able to undertake fundamental technology driven projects with payouts that may be several periods into the future.

I also do not believe that we can depend on researchers spontaneously emerging from the laboratories and forming "garage shop" small businesses to successfully execute technology transfer. Recognizing that it takes a great deal of specialized and expensive capital resources to undertake work in many of the most promising and potentially crucial advanced technologies a means to provide such facilities for small businesses is needed. The most straightforward mechanism to accomplish this may be to make existing laboratory facilities available on a rental basis. This will not only reduce the initial capital requirements of the small

business but can also help to offset the laboratory's costs of operation and maintenance of their expensive and specialized complements of facilities and equipment. Laboratories can also serve as coordinators for expanding the availability of rental facilities by encouraging consortia of local or regional larger businesses to make similar arrangements with small, high technology businesses.

The most efficient way to commercialize a laboratory developed technology is to have the direct involvement of the researcher who has been working on it. Less time is lost is "reinventing the wheel" and this can cut valuable time from the effort of getting the technology "to the market." The researchers's involvement on either a part-time or leave of absence basis, is required in the formative stages of technology transfer to the small business. Researchers themselves typically do not have either the mind set or the inclination to set up and run a private business and to deal with these problems. Furthermore, a whole series of conflict of interest and rights issues have to be worked out.

If the researchers wishes to put in the "sweat equity" and take the risks of forming or being heavily involved in a small business which is seeking to exploit (i.e. commercialize) his laboratory-developed technology, he will need support and assistance with many of the functions which are essential to a successful business. This may include, among others, financing, administration,

patent and licensing, personnel and recruiting, marketing and government research contracts expertise. These are all available for a fee, but finding them in the Midwest is a major challenge and a significant expense. Most researchers would rather be in the laboratory.

This will work! It has worked in our case, but it takes a tremendous amount of networking and negotiation. Don't expect the typical research scientist to set it up.

It is a rare occasion when the inventor of a new technology is presented with a situation where he can accumulate all of the expertise necessary to start a new business. The inventor needs far more than the space and office services of a normal incubator. What is needed are powerful, professional experience technology transfer companies who have experience in real world technology transfer and are dedicated to providing the leadership and guidance required to form and initiate technology productization companies. I believe that if the tax incentives, data rights regulations, and a risk sharing loan guarantee system were correctly tailored, a technology transfer industry would arise.

Possible Solutions

1. Technology transfer can be made less burdensome and more economically attractive by providing more liberal patent, data rights and tax policies. The various facets of this solution dictate changes in or at least a reconsideration of current policies and legislation at both the federal and state levels.

(a) On the federal level, for example, the current policy of recovering a significant portion of the government's R&D investment in defense technologies and systems by means of a recoupment surcharge on the commercial sales of items incorporating those technologies or components can and does operate as a significant impediment to small, high technology businesses. To the extent that they receive research contract support in their activities for programs which have a benefit to the nation's defense mission they take on a potentially devastating contingent liability if and as they seek to commercialize that technology.

(b) Another example of a federal policy which may actually work against a small business is the dichotomous treatment the tax laws give to R&D expenditures of certain small businesses. For firms which do business as an "S Corporation" their R&D expenditures give rise not only to a potential tax credit but also a tax preference. Unfortunately, the regulations which specify how the credit is calculated are not mirrored by the regulations covering

computation of the preference amount. For a given amount of expenditures, therefore, the potential R&D tax credit may be and usually is significantly less than the amount of tax preference. The magnitude of this difference is usually more than enough to tip the economic scales against small business R&D activities.

(c) The current system of R&D tax credits itself should be critically reevaluated to make sure that it is, in fact, encouraging the kinds and structures of research activity which will truly help to achieve our long-term goals. Presently, the R&D tax credit is keyed to incremental increases in research activity and does not necessarily prefer one form of research over another. The primary beneficiaries of the tax credit policy are large businesses with signifiant profits to shield from taxes while small, technology-oriented start ups gain little or no benefit from it. Consideration should be given, for example, to a system of R&D tax credits which encourage collaborative activities with federal or state research laboratories to transfer and commercialize specific, selected technologies in which we have enduring strategic interests. America has a more critical long-term stake in leadership in the field of superconductivity than it does in finding better ways to make a french fry. I would propose, therefore, that tax credits not be available generally and based merely upon accounting definitions of research but be targeted to small businesses, to efforts to transfer and commercialize key core technologies and that they require more than perfunctory commit-

ments to short-term objectives. It is my view that the current cost to the treasury of the present R&D tax credit system can be reduced and at the same time a focused and aggressive set of incentives can be devised which more directly accomplish the results which we as a nation require.

(d) At the state level, the policies concerning licensing the results of research conducted at public academic institutions are biased against arrangements which make the most economic sense to businesses. In addition, the prospect of actually doing collaborative research with private industry on projects which may involve a proprietary position for the business is virtually universally prohibited. Thus, while the expertise, facilities, and experience most appropriate to further research on a new technology exist at the state funded laboratory, there is no clear or distinct way for the work to be carried out in cooperation with a firm which is willing and able to commit to its commercialization.

(e) States can and should be encouraged to help fund technology transfer activities between local start ups and their leading research institutions. Some of this funding could also be in the form of R&D tax credits similar to the structure which I have proposed for the federal level. States such as those in the Midwest have even more at stake in finding ways to create new, long-term business communities in and around their publicly funded research laboratories. The benefits of "retooling" the Rust Belt

with businesses based upon tomorrow's technologies should operate as an incentive for states in this area to develop and implement innovative programs designed to facilitate and encourage "home grown" exploitation of their own technologies.

2. Changes must be made in traditional laboratory attitudes and organization. Laboratory attitudes can be made more conducive to technology transfer by selecting laboratory management on the basis of their positive attitude toward it and by mandating technology transfer advocates on the peer review panels for grants and new research initiative funding. The financial benefits resulting from technology transfer should be returned to the laboratory unit which generated the technology.

Laboratories must strive to offset and eliminate negative aspects or impediments by establishing stronger encouragements for technology transfer. Some examples of such positive reinforcements are:

(a) Giving researchers a means and opportunity to share in the economic benefits of their transferred technologies. This could range from direct profit sharing by the individual to the ability to gain and control research funding and/or facilities and equipment provided by the royalties accruing to his organization from the technology that has been successfully commercialized.

(b) Include and give significant weight to past history of success in technology transfer in the grant evaluation process. Concurrently, make changes to the present system of peer review to include in that process reviewers who themselves have a proven record of successful support of or involvement in technology transfer.

(c) Change the emphasis from "publish or perish" to "transfer or perish". So long as publication is the only or primary criterion of success you can bet that technology transfer will be left to the aggressive or the iconoclasts. This particular issue is one in which the Japanese far outdistance us and is yet another example of how technology leads are lost.

(d) Develop professional society awards and other means of recognition to honor those who are committed to technology transfer. Many people chose to enter and remain in the research field because they value recognition and reputation more than financial gain. The present systems for recognizing fundamental research and publication are quite mature but to date there are no similar mechanisms to seek out and recognize on an equal footing those researchers who achieve technology transfer.

3. <u>Companies specializing in technology transfer can be spawned by carefully focused requests for proposals</u>. In order to be responsive the proposers will have to provide the complete

infrastructure required to start the small businesses dedicated to technology transfer. The proposers will have to go far beyond the normal incubator by proactively seeking technology transfer opportunities and investing in and becoming partners with the researchers. The RFPs would be evaluated by a review panel with technology transfer experience. The RFPs should offer to provide a combination of grants, tax incentives, loan guarantees, and data rights packages to the best proposals.

These technology transfer companies will be true incubators; they seek out the most useful technologies, develop strategy, establish the personnel team, establish the partnerships and teaming agreements, and help with the financing for the venture. It is important that the technology transfer company share the risk of the venture rather than merely extracting fees from it. There are many sources of professional services that will do a small part of the job for a fee, but to the best of my knowledge, a technology transfer company as described above is virtually nonexistent in the Midwest.

I believe that a technology transfer industry would be a great benefit to society as a whole and to the Midwest region in particular because it would extract the value from technologies that will otherwise lay unused or be picked up by foreign competitors.

These proposals are controversial in that they set the stage for private companies to benefit greatly from public investments. However, under such an arrangement, the public benefits the most (by new jobs, new companies, royalties, and additional research funding) when the private company wins. We must take bold actions to motivate and facilitate technology transfer, or we will be doomed to continue on our present course.

If America is to regain its dominant position in the technologies of the future and if we are to retain the benefits of our tremendous national investment in research for our own businesses, it is essential that we focus upon the design of policies, procedures and support systems which have as their primary indicator of achievement not only the number of advances we make but also the number of jobs and businesses we create as a result of those efforts. The challenge is to harness the inherent creativity and energy of the small business community to give us the maximum return on this national investment.

Mr. STALLINGS. Thank you, Dr. Hunsinger.

Next, Dr. David Morrison, President, IIT Research Institute, here in Chicago.

Dr. Morrison, appreciate your being here.

STATEMENT OF DR. DAVID L. MORRISON, PRESIDENT, IIT RESEARCH INSTITUTE

Dr. MORRISON. Thank you very much, Mr. Chairman.

I am Dave Morrison, the President of the IIT Research Institute, headquartered here in Chicago.

I am very pleased to have been invited to testify before this subcommittee and, in particular, present my views as the head of a not-for-profit research institute on the role of our organization and others like us in the enhancement of industrial competitiveness through scientific and technical activities.

I have submitted written testimony for inclusion in the record. So, I will attempt just to summarize my results here.

First of all, mid-America is blessed with the presence of three large not-for-profit research institutes. IIT Research Institute in Chicago. Battelle Memorial Institute in Columbus, Ohio. MidWest Research Institute in Kansas City. Plus a host of smaller institutes.

These independent research institutes constitute an important regional resource for economic development through their role in the transition of technology into commercial reality.

We serve as effective brokers in the technology transfer process. Since we are not very well known as a group, I would like to spend just a few minutes describing our operations because I believe we are a role model for technology transfer and technology utilization, and if I might add, we are a model that works and not a new model.

Of the seven research institutes, Battelle and IITRI are the oldest, having been founded in 1929 and 1936, respectively. The other five were established in the middle or late 1940s.

These institutes share the common heritage that they were founded by private citizens whose aim was to enhance the strength of the economy through science and engineering.

The initial seed capital for their founding was used to establish a credible capability, to serve the needs of the public and private sectors. Competitive research contracts and royalties from licensing of intellectual property have been the only sources of income for these institutes.

They have undergone growth through the reinvestment of the net income that they have derived from the contracts that they have done, and put this investment in staff, equipment and facilities, and, of course, as not-for-profit organizations, any excess of revenues over expenses must be invested for the purposes for which the institutes were chartered.

Research institutes, in my view, have been successful because they are attuned to the needs of their clients and have served as an effective bridge between the basic research of universities and national laboratories and the needs of the private sector for new products and improved processes for competitiveness.

Research institutes understand the complete process of commercialization. They are more industry and business oriented than universities and national laboratories and more academic than commercial research laboratories.

Over the years, the research institutes have gained the confidence of industry through the credibility of their research accomplishments and their ability to perform proprietary work within defined schedules and budgets.

Their role in regional economic development has been impressive. For example, more than 50 new businesses have been founded in the Midwest by IITRI staff members who have spun off new businesses from our organization, and I am sure the other research institutes have records to mateh this.

N.A.S.A. has used us to facilitate its technology transfer programs to industry, and the Department of Commerce has called upon our expertise to provide technical support to small companies adversely impacted by foreign trade.

The technical knowledge we have gained through government contracts is effectively used to bring technology to industry. Over the past several years, for example, IITRI has been providing its technical expertise in electro-magnetic pulse effects to a small minority business in Chicago that is developing airborne communications systems. A significant number of new jobs have been added to Chicago through the growth of the company.

Another example of regional economic development can be illustrated through IITRI's experiences in Bartlesville, Oklahoma. In the early 1980s, the Federal Government seriously considered closing the Bartlesville Energy Technology Center that had been established in 1918. It was the lead laboratory for the Department of Energy into oil and gas research and was staffed by 150 federal employees.

If BETC, as it was then known, were closed, the community of Bartlesville would have lost its third largest employer, and the independent oil and gas producers in the region would have lost a technical resource.

Through a competition limited to not-for-profit organizations, IITRI was awarded a cooperative agreement in August 1983 to operate what is now known as the National Institute for Petroleum and Energy Research. Under this agreement, IITRI acquired the 150 employees who had been severed from the federal payroll and had access to the equipment and facilities in Bartlesville under a use permit.

D.O.E. committed $35 million over a five-year period to NIPER and IITRI had a goal to raise an additional $15 million in research and development contracts.

I am pleased to report that over the five and a half years that IITRI has operated NIPER, the partnership between the Federal Government and the State of Oklahoma and IITRI has been a success. The number of employees at NIPER has grown from a 150 to more than 200, thus preserving jobs in a local economy that has been beset by considerable decrease in employment by the principal employer in the community, a major oil company.

During the first five years of its operation, IITRI has secured contracts totalling some sixty-five percent more than our goal of

$15 million, and, more importantly, we have provided technical support to more than 130 organizations in the region engaged in the production of oil and gas and the refining of petroleum and the utilization of fuels.

Without the experience that IITRI has as a not-for-profit institute, through working for industry over the years, that record of success would have been much less certain.

To complement the current activities, to improve industrial competitiveness through the use of national laboratories and the stimulation of industry-university partnerships, I believe it would be prudent for Congress and the Administration to examine the role that not-for-profit institutes have played in economic development for more than fifty years.

This human and facility resource base should be tapped and made a full partner in all federal programs aimed at the stimulation of our economy. Unfortunately, set-asides for universities, designated budgets for national laboratories, and the low or no fee contracts that are offered to not-for-profits inhibit our ability to pursue the nationally-important goal of competitiveness.

The significant base of federal funding and the first-hand experience of research institutes in working with industry on practical problems are essential keys to near-term success.

Based upon this broad perspective from the not-for-profit institutes and perhaps more narrowly on the factors that I believe are affecting IITRI's operation at the present time, I would like to address six policies that affect us and, in turn, I think, affect our ability to assist industry.

First, from a national point of view, the Federal Government should increase R&D funding, especially the share of R&D funds that are spent by non-defense agencies.

A strong technology base is a necessary element of our nation's competitive strength. We are under-investing in our technology compared to our trading partners, and benefits from federal funding of R&D have reached many sectors of our economy regardless of the agency or the initial purpose of the funds.

For example, under Defense Department funding, IITRI established a reliability analysis center in 1972. This center is now a scientific information resource for the Defense Department in all areas of reliability, maintainability and quality control.

Industry now turns to IITRI for reliability technology as well as related support spawned by this center in such areas as statistical process control, quality productivity enhancement, and computer-integrated manufacturing.

While the Department of Defense funds do tend to benefit certain industries directly, the increased federal funding through civil agencies to stimulate technological advances in other industries, such as machinery, fabricated metals, professional and scientific instruments and food and beverages.

The Illinois Institute of Technology and IITRI are pleased that the Food and Drug Administration has recently funded the establishment of the National Center for Food Safety and Technology in Chicago.

Through collaborative projects involving government, industry, IIT and IITRI, this center will directly benefit one of the major in-

dustries in mid-America that traditionally does not receive federal R&D funds.

Secondly, I believe that the R&D tax credit should be increased and made permanent. I will not comment on this further, because several other speakers this morning touched on the same point, I certainly underscore their recommendations.

Third, additional centers should be established and focused on technologies that are fundamental to basic manufacturing and services industries.

The efforts that the Federal Government has made to establish centers, such as the NSF Engineering Research Centers and the Hollings Centers, should be expanded.

In mid-America, in particular, there are many industries, comprised to a great extent of small and medium sized companies, that clearly lack the contemporary technology base to be competitive.

Centers should be established to fulfill two functions. First, to promote the understanding and advancement of generic technologies to strengthen the industrial base, and, second, to facilitate the transfer of this technology, especially to the small and medium sized companies.

While cost-sharing by states and industry is desirable, we should be sure that ample funds are provided so that the continuity of the program can be maintained over a period long enough to achieve technical progress, in some cases, this may be a five to ten year period.

As Jay Hedges mentioned earlier this morning, the Center for Advanced Manufacturing Technology for the gear industry that is currently being procured by the Defense Department is a good example.

Such a center is important to the Midwest since more than thirty-four percent of the precision gear manufacturers are located in this region. Illinois and, I believe, Ohio are competing against several other locations for this center, and obviously a combination of federal, state and industrial funds will support this center.

Other centers that should be included would be in areas, such as sensors and intelligent control systems, combustion and heat-treating technology, and medical instrumentation. These technologies are and should be used more widely by industry, and federal, state and industrial coalitions are emerging as the effective means to spawn and support such technology development and support centers.

Fourth, I believe that a center or centers should be established devoted to the development and application of technologies for the refurbishment of existing urban centers.

It is no secret that the infrastructure within major older urban centers throughout the United States is showing its signs of aging. Transportation networks, water and sewage systems, housing, communications networks, are all outmoded, in need of refurbishment, and not optimum to maintain, attract and support a strong competitive industrial basis.

The longer we delay addressing these problems, the worse it will get, and the more industries and jobs will migrate from mid-America. Congress should establish an urban infrastructure program to use available and emerging technologies to rebuild our centers of

industrial strength, to improve the environment for manufacturing enterprises, and thereby indirectly increase our economic competitiveness.

In my opinion, Chicago is the logical place for such a center. Not only does it have the technological resources to address urban problems in a real environment, but it has the support of the city government to launch such an activity.

Let me highlight just two others that are very important to my organization and I think the other not-for-profit institutes.

The liabilities for research and development efforts and their application to national problems should be limited. The not-for-profit research institutes are becoming more restricted in their operations through increasing liabilities.

As organizations independent of both the Federal Government and commercial enterprises, we are often called upon to address critical environmental and public safety problems, the solutions to which carry long-term and very high-cost risks.

If these problems are not resolved through the use of remedial technologies, the business environment for competitiveness is impaired. Yet, the development of technical solutions for problems, such as asbestos control and hazardous waste management, may carry with them uninsurable risks.

In addition to the litigious environment in which the not-for-profits as well as all businesses now operate has greatly increased the needs and costs for liability insurance, particularly professional liability. Some means must be found at the national level to bound the financial risks associated with research and development for technical services. Otherwise, well-qualified organizations will no longer be willing or able to provide this technical service to address these critical problems.

As my last point, it is essential in my mind that the tax exemption on especially applied research and development be maintained. If not-for-profit institutes are to serve our national needs effectively, it is important that their earnings be available to reinvest for their corporate purposes.

Any change in the existing tax laws that unfavorably altered the definition of unrelated business income, such as taxing of applied research and development, would be counter-productive.

I hope that these narrow views of mine from the not-for-profit community will be useful to the subcommittee in its deliberations.

[The prepared statement of Dr. Morrison follows:]

TESTIMONY

ON

MID-AMERICA SCIENCE AND TECHNOLOGY PRIORITIES

before the

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES

by

David L. Morrison
President and Chief Operating Officer
IIT Research Institute

February 10, 1989

97-750 O - 89 - 7

TESTIMONY

TO

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

HOUSE SPACE, SCIENCE AND TECHNOLOGY COMMITTEE

by

David L. Morrison
IIT Research Institute
February 10, 1989

I am David Morrison, President of the IIT Research Institute headquartered in Chicago. I'm pleased to have been invited to testify before this Subcommittee on Energy Research and Development and to present my views as the head of a not-for-profit research institute on the role of our organization and others like us in the enhancement of industrial competitiveness through scientific and technical activities. Mid-America is blessed with the presence of three large not-for-profit institutes - the IIT Research Institute in Chicago, Battelle Memorial Institute in Columbus, Ohio, and Midwest Research Institute in Kansas City - plus a host of smaller institutes.

The history and operations of not-for-profit research institutes provides perspective on the contributions we have made to our nation's economy as well as a role model for transition of technology into commercial reality. According to National Science Foundation statistics, the research institutes perform about 3% of total R&D in the United States based upon funds expended. The federal government is the source of approximately two-thirds of these funds and the private sector provides the remainder. Almost all of the funds are obtained through competitive contracts for research, development, and technical services. Only a few grants are received by these institutes.

Of the seven largest research institutes, Battelle and IITRI are the oldest, having been established in 1929 and 1936, respectively; the other five, SRI International, Southwest Research Institute, Midwest Research Institute, Research Triangle Institute, and Southern Research Institute, were established in the middle and late 1940's. These institutes share the common heritage that they were founded by private citizens whose aim was to enhance the strength of the economy through science and engineering. The initial seed capital for their founding was used to establish a credible capability to serve the needs of the private and public sectors. Competitive research contracts and royalties from the licensing of intellectual property have been the only sources of income for the institutes. Growth has occurred through reinvestment of the net income derived from these contracts in additional staff, equipment, and facilities. As not-for-profit organizations, excess of revenues over expenses must be invested in the purposes for which the institutes were chartered.

The research institutes have been successful because they are attuned to their client's needs and have served as effective bridges between basic research at universities and national laboratories and the needs of the

private sector for new products and improved processes for competitiveness. Research institutes understand the complete process of commercialization. They are more industry and business oriented than universities and national laboratories, and more academic than commercial research laboratories. Industry has confidence in the research institutes through the credibility of their accomplishments and by virtue of their ability to perform proprietary work within a defined schedule and budget.

Many products have had their origins at research institutes: dry photocopying or xerography, magnetic recording, and the technology and system of magnetically encoded bank checks. A host of other commercial products ranging from pharmaceuticals and medical instrumentation, foods and beverages, electronic devices, transportation systems, to advanced materials have been developed and improved under proprietary projects for industrial clients. Development of advanced processes and process improvements for manufacturing, chemical, and electronics industries have been the focus of many industrial contracts.

The role of the not-for-profit institutes in regional economic development has been impressive. For example, more than 50 new businesses have been founded in the Midwest by IITRI staff members, and the other research institutes have similar records. NASA has used us to facilitate it's successful technology transfer programs to industry, and the Department of Commerce has called upon our expertise to provide technical support to small companies adversely impacted by foreign trade. The technical knowledge we have gained through government contracts is effectively used to bring new technology to industry. Over the past several years, IITRI, for example, has been providing its technical expertise in electromagnetic-pulse effects to a small minority business in Chicago that is developing airborne communications systems. A significant number of new jobs have been added to Chicago through the growth of this company.

Another example of regional economic development can be illustrated through IITRI's experiences in Bartlesville, Oklahoma. In the early 1980's the federal government seriously considered closing the Bartlesville Energy Technology Center (BETC) that had been established in 1918. It was the lead laboratory for the Department of Energy (DOE) in oil and gas research, and was staffed by 150 federal employees. If BETC as it was then known were closed, the community of Bartlesville would have lost its third largest employer and the independent oil and gas producers in the region would have lost a technical resource.

After further deliberation, DOE decided to offer some of the programs and all of the staff of the laboratory to the private sector. A competition limited to not-for-profit organizations was held, and in August 1983 IITRI was awarded a cooperative agreement to operate the National Institute for Petroleum and Energy Research. Under this agreement, IITRI acquired the 150 employees who had been severed from the federal payroll, and had access to the equipment and facilities in Bartlesville under a use-permit. DOE committed $35-million over a 5-year period to NIPER, and IITRI had a goal to raise an additional $15-million in research and development contracts.

I'm pleased to report that over the 5-1/2 years IITRI has operated NIPER, the partnership between the federal government, the State of Oklahoma, and my not-for-profit institute has been a success. The number of employees at NIPER has grown from 150 to more than 200, thus preserving jobs in the local economy that has been beset with considerable decrease in employment by the principal employer in the community, a major oil company. During the first 5-years of operation, IITRI has secured contracts totalling $25.6-million, $10.6-million more than our goal of $15-million. More importantly, we have provided technical support to more than 130 organizations in the region engaged in the production of oil and gas, in the refining of petroleum, and in utilization of fuels. Without the experience that IITRI as a not-for-profit institute has gained in working for industry, the record of success would have been much less certain.

To complement the current activities of the federal government to improve industrial competitiveness through the use of national laboratories and the stimulation of industry-university partnerships, it would be prudent for Congress and the Administration to examine the role that not-for-profit institutes have played in economic development for more than 50 years. This human and facility resource base should be tapped and made a full partner in all federal programs aimed at the stimulation of our economy. Set-asides for universities, designated budgets for national laboratories, and low or no fees allowed to not-for-profits inhibit the ability of research institutes to pursue the nationally important goal of competitiveness. A significant base of federal funding and the first-hand experience of the research institutes in working with industry on practical problems are the essential keys to near-term success.

Not all actions taken by Congress have been negative. The federal policy adopted several years ago that permitted not-for-profit institutes to take title to intellectual property developed under government contracts has provided an additional resource for increasing international competitiveness. This action has made federally developed technology more attractive to industry, and has made it easier for organizations such as IITRI to transfer technology into commercial applications. This policy is good and is being implemented effectively. The recent congressional authorization to make not-for-profit institutes eligible for facilities modernization monies from the National Science Foundation is also a favorable action.

Based upon my perspective from the experience of the not-for-profit institutes, I offer the following suggestions for your consideration to enhance competitiveness in Mid-America.

1. <u>Increase the total R&D funding by the Federal Government, and increase the share of R&D funds being spent by non-defense agencies</u>.

   A strong technology base is a necessary element of our nation's competitive strength. We are underinvesting in our economy compared to our major trading partners. Japan, for example, invests 3% of its GNP in non-defense R&D while the United States spends only about 1.9%. Through the not-for-profit institutes, benefits from federal funding of R&D have reached many sectors of our economy regardless of agency or initial purpose of the funds. A recent NSF study has revealed that companies

involved in restructurings and leveraged buy-outs decrease R&D spending. Federal funds available to research institutes through competitive procurements can help to offset the decrease in technical capacity due to mergers and acquisitions.

Let me cite some examples of how federal funds for R&D benefit industry. Under Department of Defense funding, IITRI established the Reliability Analysis Center (RAC) in 1972. This center is now a scientific and information resource for DOD in all areas of reliability, maintainability, and quality control. Industry also turns to IITRI for reliability technology as well as related support spawned by the RAC in areas such as statistical process control, quality productivity enhancement, and computer integrated manufacturing. Defense Department funds do tend to benefit certain industries directly, and increased federal funding through civilian agencies can stimulate technological advances in other industries such as machinery, fabricated metals, professional and scientific instruments, and food and beverage. The Illinois Institute of Technology and IITRI are pleased that the Food and Drug Administration has recently funded the establishment of the National Center for Food Safety and Technology in Chicago. Through collaborative projects involving government, industry, IIT and IITRI, this Center will directly benefit one of the major industries in Mid-America that traditionally does not receive federal R&D funds.

With regard to academic research and education, increases in the budget for the National Science Foundation are essential. Doubling of this budget over a 5-year period would show a national commitment to our science base, and sustain and expand basic research activities and related education programs. University programs in other agencies should also be expanded.

2. Enact a permanent R&D tax credit

Since 1981, industry has benefitted from the tax credits it has received on R&D. This credit has stimulated companies to expand their R&D budgets and develop improvements in their products and processes to enhance their competitive position. The experience has been positive, and the R&D credit should be made permanent.

3. Establish additional centers focused on technologies fundamental to basic manufacturing and services

The efforts that the Federal government has made to establish centers such as the NSF engineering research centers and the Hollings centers should be expanded. In Mid-America in particular there are many industries, comprised to a great extent of small and medium sized companies, that clearly lack a contemporary technology base to be competitive. Centers should be established to fulfill two functions: promote the understanding and advancement of generic technologies to strengthen the industrial base, and facilitate the transfer of this technology, especially to small and medium sized companies. While cost-sharing by states and industry is desirable, ample federal funds must be provided to assure the continuity of the programs over a long enough period of time to achieve technical progress

(5 to 10 years may be required) and to support the participation by small and medium sized companies.

The center for advanced manufacturing technology for the gear industry that is currently being procured by the Defense Department is a good example. An instrumented factory for the manufacture of precision gears will be established to develop, test, and demonstrate advances in technology. Such a center is important to Mid-America since more than 34% of the precision gear manufacturers are located in this region. Illinois and Ohio are both competing against several other locations for this center. A combination of federal, state, and industrial funds will support the center.

Other centers should be considered on subjects such as sensors and intelligent control systems, combustion and heat treating technology, and medical instrumentation.. These technologies are or should be used more widely by industry. Federal, state, and industrial coalitions are emerging as effective means to spawn and support such technology development and support centers. In some cases the formation of these centers has evolved into a competition between states, and depend upon the willingness and ability of a state to provide the seed capital. This does not necessarily lead to the best combination of research capability, location, and industrial need. All states should be encouraged to budget for these centers, and ample federal funds should be available to start these centers under the guidance of an independent board or commission that can seek to obtain the maximum improvement in industrial competitiveness from the total funds invested regardless of source.

4. Establish a center or centers devoted to the development and application of technologies for the refurbishment of existing urban centers such as Chicago

It is no secret that the infrastructure within the major, older urban centers throughout the United States is showing signs of aging. Transportation networks, water and sewage systems, housing, and communication networks are outmoded, in need of refurbishment, and not optimum to maintain, attract, and support a strong, competitive industrial base. The longer we delay addressing the problem, the worse it will get and the more industries and jobs will migrate from Mid-America. Congress should establish an urban infrastructure program to use available and emerging technologies to rebuild our centers of industrial strength improve the environment for manufacturing enterprises, and thereby indirectly increase our economic competitiveness. In my opinion, Chicago is a logical place for such a center. Not only does it have the technological resources to address the urban problems in a real environment, but it has support of the city government to launch such an activity.

5. Limit liabilities for research and development efforts and their applications to national problems

The not-for-profit research institutes are becoming more restrained in their operations through increasing liabilities. As organizations independent of both the federal government and commercial enterprises, we

are often called upon to address critical environmental and public safety problems, the solutions to which carry long-term high risks. If these problems are not resolved through the use of remedial technologies, the business environment for competitiveness is impaired. Yet the development of technical solutions for problems such as asbestos control and hazardous waste treatment may carry with them uninsurable risks. In addition the litigious environment in which the not-for-profits as well as all businesses now operate has greatly increased the need and costs of liability insurance, particularly professional liability. Some means needs to be found at the national level to bound the financial risks associated with research, development, and technical services. Otherwise, well qualified organizations will no longer be willing or able to provide this technical expertise to address critical problems.

6. Maintain the tax exemption for applied research and development

If the not-for-profit institutes are to serve our national needs effectively, it is important that their earnings be available to reinvest for their corporate purposes. Any change in the tax laws that unfavorably alter the definition of unrelated business income, such as taxing applied research and development, would be counterproductive.

Mr. STALLINGS. Thank you, Dr. Morrison.

Our final witness this afternoon is Mr. Donald P. McConnell, General Manager, Design and Manufacturing Engineering at Battelle.

Thank you for being with us this afternoon, Mr. McConnell.

STATEMENT OF DONALD P. McCONNELL, GENERAL MANAGER, DESIGN AND MANUFACTURING ENGINEERING, BATTELLE

Mr. MCCONNELL. Thank you, Mr. Chairman, and good afternoon.

As you have indicated, I am Don McConnell, and my function is as Group Vice President of Design and Manufacturing Engineering at the Battelle Memorial Institute.

As Dr. Morrison alluded, since 1929, Battelle is an international technology organization that serves industrial and government clients in 35 countries by developing, commercializing and managing technology.

Our corporate offices are located in Columbus, Ohio, and we have major facilities in the U.S. and Europe, most notably being the operation of the Pacific Northwest Lab in Richland, Washington, for DOE.

One of the things that being a not-for-profit institution has enabled us to do over the years is to maintain a window on what industrial America is doing and act as a facilitator and a broker for bringing technologies into being and putting them into practice by American industry.

I am here today to give you some of the perspectives that I see on the process, what is inhibiting some of the application of technology and how it has impacted our competitive position, particularly the manufacturing base that is represented in the Midwest region.

I also would like to discuss the accelerated need for innovation in manufacturing processes, and the obstacles that are thwarting these needs being accepted by American industry.

I also will touch on federal and state government roles in establishing a national policy for supporting industrial competitiveness and for positioning American industry to compete successfully in a global market of the future.

At the beginning of each year, Battelle publishes a forecast on research and development spending in the United States for the upcoming year. We have examined how much money we believe is going to be spent by R&D, by both the Federal Government and by industry, and how that funding is going to be disseminated.

This year, our estimated numbers for federal R&D support bear a striking resemblance to numbers for the past twenty years. The lion's share of federal R&D funds once again will go towards defense projects.

For 1989, we estimate 60 percent of federal support for R&D will go to the Department of Defense alone and more, perhaps about 10 percent more, will be spent on defense projects by other agencies, such as the Department of Energy and NASA, in support of defense.

Much of this funding will go towards designing new and innovative defense systems meeting a clearly-articulated national priority

to meet America's national security needs, but considerably less will be spent on developing the industrial processes that building these systems requires or in positioning American industry for the broader and far less clearly articulated national priority of maintaining America's position in the global competition for markets and, in turn, the economic security of the nation.

As we are all aware, the defense spending for weapons systems over the past several years has increased. However, we have also seen the erosion of federal support for the advancement of the industrial base in R&D funding.

Research and development today is heavily self-funded at the manufacturing and production industries, where, on average, less than a third will be supported by the Federal Government.

Many industries receive little or no government support as may be appropriate. For example, the chemical industry will do some $11.5 billion worth of R&D in 1989, 96 percent of it funded by the industry itself.

Automotive industry, which is prevalent in this region, will fund 83 percent of its $11.4 billion worth of research. Many industries related to petroleum, textiles, foods, beverages, pulp and paper, many in the areas where we compete around the world, will receive virtually no government support.

In many ways, total industrial R&D investment is the single greatest pool of technology development in the United States, and, yet, when we consider the real increases in R&D expenditure, looking at both government and private spending, in 1989, we expect to see only a 2-percent real growth, hardly the level of output that is required to maintain and gain a competitive position in the global marketplace.

Let us take a closer look at defense R&D and its relationship with manufacturing and productivity in the global marketplace.

Historically, our defense sector has relied on the strength of the American manufacturing base to respond to demands made by defense systems, but throughout the years, the U.S. has assumed that manufacturers are capable of developing any product that is designed and doing it effectively.

Defense procurement has emphasized purchasing items required for military use, assuming that manufacturers have the know-how and resources from commercial production in order to achieve this. While defense R&D programs finance the development and design of weapons, little has been spent on the facilities and processes required to create these products.

Although defense research has been strengthened over the years, since the mid-1950s, the focus on end product has left little regard for the manufacturing processes needed to create the end product.

In addition, the focus on qualitative rather than quantitative superiority in weapons systems has led to a greater and greater sophistication in the development of weapons systems that has not been followed in the industrial marketplace.

Because little attention was paid to manufacturing processes, many sophisticated devices cannot now be manufactured at acceptable speed or acceptable quality standards for global competition.

The United States has suffered badly in areas of micro-electronics and precision electro-mechanical devices and is now at a competitive disadvantage in these areas.

Coincidentally, civil sector manufacturing has followed the defense sector procedure of emphasizing end product and short-term goals, but success in today's market is achieved by those producers who most rapidly commercialize new technologies regardless of who is developing them.

With the events of the past half decade, major segments of American industry have felt more pressure to increase stock values for the short-term rather than to position for the future.

In order to meet investors expectations, this trend has accelerated in the last few years. This has tended to place a higher value on short-term gain rather than long-term growth.

Increasingly, real innovation in American industry has been driven by smaller companies. National Association of Manufacturers estimates that in the past few years, more than 55 percent of all innovation has come from small companies. In addition, of the 1.3 million jobs that were created in manufacturing employment this last decade, over 1.4 million jobs were created by small manufacturers.

A lot of these companies to compete and expand their innovation is a key challenge to those of us who are involved in science and technology, its competitive application and to those who establish national priorities.

Small manufacturing firms can, with proper support, be leaders in innovation. Let me cite one encouraging example.

Battelle recently completed work for a client, Peerless Saw, which manufactures circular saw blades for the industrial marketplace. This company is faced with growing competition from overseas and was concerned about its ability to compete in the long run.

We were asked to analyze the situation and ultimately help the company select and install an automated laser cutting system that enabled the firm to design blades on a computer terminal and automatically turn them into blades on the shop floor.

Because the new system drastically reduced the time required to produce a new design, Peerless could meet the demands of the smaller custom orders and it once again became competitive in producing custom saw blades.

More significantly perhaps, Peerless today has expanded into a whole new business area in custom sheet metal for the automotive industry. Such an opportunity for a small company is not all that far-fetched and many companies could, with the right incentives, respond. Peerless now is a $50 million a year business.

As Peerless Saw discovered, successfully bringing technology to the marketplace requires a major investment in time and in money and in support from management as well as from the investor. Proper manufacturing processes must be developed for the U.S. as a nation to become and remain competitive with such global manufacturing giants as Japan, which, incidentally, is one of Battelle's biggest clients for highly-innovative technology.

The Japanese believe manufacturing is as important as product innovation or marketing in their quest to obtain market share.

When developing R&D strategy, Japanese firms are willing to look and to invest in the future rather than focus solely on short-term profits.

Over 90 percent of the Japanese R&D funding is directed to civil sector manufacturing. I believe that we can learn an important lesson here about the importance of developing a strategic alliance between government, industry, universities, the national labs and independent providers in improving American competitiveness.

It is important to note that while the Japanese have played a major role in developing countries solve manufacturing base, we have had the opportunity in this country to take initiatives towards that end.

Many of the states in which we are speaking today have taken an opportunity to establish state programs geared towards enhancing manufacturing competitiveness. Likewise, we have seen a number of firms come together to form consortiums in R&D, something which has been encouraged by tax law revisions.

Our firms will succeed not by looking at next week or next year, but by perceiving that the next 5, 10 or 20 years are critical to our competitive position and to their place in the marketplace.

If our government incentives can be geared towards the development and investment in technology and competitive position, we have the opportunity to be more competitive.

We have also some examples where, by taking the right initiative, we can transfer technology into the United States. When we encourage firms to join together in partnerships with other companies, either domestic or foreign, we have the opportunity to pool resources which would otherwise be too small to capitalize on a particular position.

Technology moves so fast today that alliances may be the only way to stay competitive in a great many industries. At Battelle, we currently have an example where we formed a joint venture with Nippon Telephone and Telegraph and Mitsubishi Corporation in which we have formed a company in Columbus, Ohio, dealing with a very sophisticated opto-electronics technology developed by the Japanese.

Our goal here is to introduce this technology into U.S.-based companies to produce these components.

We often hear of American ingenuity being put into practice by the Japanese, whether it is statistical process control or automation. This is a fine example of bringing foreign technology into the U.S. to make it available here.

Another example of the value of partnerships is in the area of developing high-speed passenger jets for early in the next century. The cost of developing such a supersonic aircraft are so high that it would require a world consortium to make this plan a reality.

Three years ago, Battelle formed the Center for High-Speed Commercial Flight to act as a catalyst to bring together 25 companies from the U.S., Europe and Japan, airline and freight companies, airframe manufacturers, engine makers, and financial sources, as well as government representatives.

We are now very close to launching the first research stage in this tremendous undertaking.

Our government has taken steps to foster this type of partnering effort, several years ago, by rolling back the aspects of anti-trust law related to research and development. However, since that time, many firms are still unwilling to form long-term partnerships because of concerns on anti-trust.

Certainly, anti-trust laws continue to inhibit this type of partnership. The problem extends well into our business culture relationships. Our government can set the stage for increasing America's competitiveness by encouraging the formation of partnerships and removing the impediments to advancing technology through such consortia over time.

There are private initiatives that have been taken that are good examples of how we can also group to compete. Some of those you heard about this morning in terms of the National Centers for Manufacturing Sciences. I would like to cite one additional one, the Center for Materials Fabrication.

In this particular instance, Battelle operates a center funded jointly by the electric utilities of the United States as well as individual manufacturers to develop and apply new process technologies that increase the competitiveness and cost-effectiveness of manufacturing processes.

This has seen a wide base of support with seed money from the utilities being matched by funding from individual companies. That now represents a success story for American manufacturing that could be replicated in other areas of activity whether it is in machining or in metals fabrications or in electronics.

Similarly, state programs have had an impact in developing industry and university consortium relationships to improve industrial competitiveness. Ohio's Edison Program, Pennsylvania's Franklin Program, are good examples as is Indiana's recent start.

However, the small firms that need manufacturing and advance technology most are also the ones that can least afford to invest within these programs.

In the work that we have done with Ohio's Edison Program, what we find repeatedly is that small companies can afford the entry fee to simply become aware of what is going on, but cannot really afford the time or resources to continue to participate unless an outside source is willing to fund technology to the point where the risk of its application has been reduced to manageable levels.

This is critical to American industry. The vast majority of manufacturing employment in the Midwest region is in firms with less than 200 workers, the same firms that are least capable of funding such implementation themselves.

Competing is a real struggle for the small manufacturers. They must be concerned with reducing the risk of failure and, as a result, are not always the first in the technology race and may be passed by.

Government can help these small firms by providing the necessary incentives, such as the R&D credits, for them to invest in the long-term and especially by reducing the risks involved in new technologies by fielding consortia for demonstration and development of such technologies.

But they must have incentives to participate in longstanding programs, be they Ohio's Edison Programs or similar programs, that bring innovative technology to the shop floor.

In conclusion, I would like to re-emphasize that U.S. manufacturing firms have begun to realize what they must do to stay competitive. American industry is producing world class products and competing effectively in the world marketplace, but they must use this technology wisely and work smarter in order to compete tomorrow.

Our economic and, in turn, our military well-being depend on the strength of American manufacturing. Without innovative manufacturing processes and the will to implement them, the U.S. will find itself unable to produce the consumer products and defense systems that will be required over the next two decades.

The primary responsibility for facilitating and establishing a foundation for this manufacturing service rests with industry and its partnership with government. Our firms must have the incentives to invest in the long-range future and our country must, as most world governments have discovered, have a national strategy for providing these incentives.

Thank you, Mr. Chairman.

[The prepared statement of Mr. McConnell follows:]

TESTIMONY TO U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT

DON MCCONNELL, GROUP VICE PRESIDENT,

DESIGN AND MANUFACTURING ENGINEERING,

BATTELLE

FEBRUARY 10, 1989

Good afternoon. I want to thank you for inviting us to speak with you today. I'm Don McConnell, and I serve as Group Vice President of Design and Manufacturing Engineering at Battelle Memorial Institute. Battelle is an international technology organization that serves industrial and government clients in 35 countries by developing, commercializing, and managing technology. Our corporate offices are located in Columbus, Ohio, and we have major facilities in the U.S. and Europe and offices throughout the U.S. and the world.

I'm here today to talk about the current state of research and development and industrial competitiveness in the Midwest and across our nation. I want to discuss the accelerating need for innovation in the manufacturing process and the obstacles that are thwarting meeting this need. I also plan to address the role of federal and state government in establishing a national policy for supporting industrial competitiveness and for positioning American industry to compete successfully in the global market of the future.

At the beginning of each year, Battelle publishes a forecast for research and development (R&D) spending in the United States for the upcoming year. We examine how much money we believe is going to be spent for R&D, by whom, in what areas, and who will conduct this R&D. This year, our estimated numbers for federal R&D support bear a striking resemblance to numbers for the past 20 years--the lion's share of federal R&D funds once again will go toward defense projects. For 1989, we estimate 60 percent of federal support for R&D will go to the Department of Defense alone, and more--perhaps about 10 percent--will be spent on defense projects by other agencies, such as the Department of Energy and the National Aeronautics and Space Administration. Much of this funding will go toward designing new and innovative defense systems, meeting a clearly articulated national priority to meet America's military security needs. But considerably less will be spent on developing the industrial processes to build those systems, or in positioning American industry for the broader--and less clearly articulated--national priority of maintaining America's position in the global competition for markets and, in turn, economic security.

As we all are aware, this defense spending for end products over the past several years has increased. However, we've also seen the erosion of federal support to the advancement of the industrial base of R&D funding. Research and development is heavily self-funded in the manufacturing production industries, where, on the average, less than a third will be funded by the federal government. Many industries will receive little or no government R&D support at all. For example:

- The chemicals industry will perform $11.5 billion worth of R&D in 1989, with 96.7 percent funded by industry.
- The machinery industry, which will do $12.1 billion worth of R&D, will fund 86.2 percent from its own monies.
- The automotive industry will fund 82.6 percent of the $11.4 billion worth of R&D it will perform.
- And industries related to petroleum products, textiles, foods and beverages, and paper and pulp will receive virtually no government support.

And when we consider that real increases in R&D expenditures--both government and private--are estimated to be only 2 percent this year, the outlook for advancing our competitive position of product development and our manufacturing base looks less than optimistic.

Now, let's take a look at defense R&D and its relationship with manufacturing. Historically, our defense sector has relied on the strength of the American manufacturing base to respond to the demands made by defense systems. But through the years, the U.S. has assumed that manufacturers are capable of developing any product that is designed. Defense procurement has emphasized purchasing items required for military use, assuming the manufacturers had the know-how and resources to produce designers' ideas. While defense R&D programs financed the development and design of weapons needed by the military, industry was expected to develop the technologies and facilities required to create these products. In some instances, without proper federal funding this just could not be done.

Although defense research emphasized production as a key element of the national security's strategy until the mid-1950s, the focus of defense research since then has been on the end product--with the U.S. holding little regard for the manufacturing process needed to create that end product. Weapons systems' qualitative, rather than quantitative, superiority has become the goal, resulting the production of a smaller number of weapons, but which now are very sophisticated.

Because little attention is paid to developing the manufacturing processes, many sophisticated devices cannot be manufactured at acceptable speed or at acceptable quality standards. So we are creating very sophisticated defense systems from advanced technologies, but when the products are put to use, they can suffer from reliability and supportability problems--many

of which are traceable to failures in manufacturing technology to realize the potential of designs.

Coincidentally, civil-sector manufacturing has followed the defense sector's procedure of emphasizing end products and short-term goals. But success in today's market is achieved by those producers who can most rapidly commercialize new technologies--regardless of who developed them. With the events of the past half decade, major segments of American industry have felt more pressure to increase stock values in the short term, rather than in position for the future, in order to meet investors' expectations. This tends to place reduced value on long-term growth.

Increasingly, real innovation in American industry has been driven by smaller companies. The National Association of Manufacturers estimates that in the past few years more than 55 percent of all innovation has come from small companies. In addition, of the 1.3 million job rise in manufacturing employment in the past decade, more than 1.4 million jobs were created by small manufacturers. Allowing these companies to compete and expand their innovation is a key challenge to both those of us who develop and apply competitive technologies and to those of us who establish national policy. Smaller manufacturing firms can, with proper support, be leaders in innovation. But there is currently no national industrial policy to set this stage.

Battelle recently completed work for a client, Peerless Saw, which proved that small businesses can compete when given the opportunity. A maker of circular saw blades, the company was faced with growing competition and was concerned about its ability to compete. We were asked to analyze the situation and ultimately helped the company select and install an automated laser cutting system that enabled the firm to design blades on a computer terminal and automatically turn them into real blades on the shop floor. Because the new system drastically reduced time, Peerless could meet the demand for smaller, custom orders, and it became competitive again in producing custom saw blades. More significantly, perhaps, Peerless also was able to expand into a whole new business in custom sheet metal cutting.

As Peerless Saw discovered, successfully bringing technology to the marketplace requires a major investment--money, time, and support from management as well as the investor. Proper manufacturing processes must be developed by the U.S. for this nation to become, and remain, competitive with such manufacturing giants as Japan, which incidentally is one of Battelle's biggest clients for highly innovative technology. The Japanese believe manufacturing is as important as product innovation or marketing in their quest to obtain the market share. When developing R&D strategy, Japanese firms are willing to look to, and invest in, the future rather than focus solely on current or short-term profits. About 90 percent of Japanese R&D funding is directed to civil-sector manufacturing. I believe that we can learn an important lesson here about the importance of developing a strategic alliance between the government, industry, universities, and independent providers in improving American competitiveness.

It is important to note that the Japanese government has played a major role in developing that country's solid manufacturing base, which has helped lead to Japan's vast economic and technological gains over the past 20 years. Likewise, the United States must establish the elements of a national policy for positioning ourselves for the future.

U.S. manufacturers are now beginning to realize they must change their attitudes about the way they manage their businesses. They now have a much clearer idea of what they must do to compete effectively in the world marketplace. They are engaged in corporate restructuring, improving the productivity of their workforces, investing in automation technology, and just plain working smarter. They are beginning to see they can no longer be complacent; they must be competitive.

Our government must play a role in this revitalization of American manufacturing. We must nationally recognize that we cannot compete globally as a "service" economy. We must as a national policy seek to join productivity and our competitive position. While many firms and trade associations all speak forcefully about reducing the burdens of taxation and trade imbalances, gains in such areas are transitory at best. There must be a national policy on support for industrial competitiveness through both R&D innovation and implementation. This policy must stimulate and focus attention on the longer term. We cannot afford to evaluate our industry by looking to current stock value as a measure of success. Our firms will succeed not by looking at next week or next year, but by perceiving the next five, ten, or twenty years. Yet, our present government incentives are geared primarily toward dissemination rather than development of technology; they look toward the near term and do not take the initiative in closing the technological gaps that exist between the demands for world-quality products and the processes to produce them at competitive costs.

This new national policy also must encourage firms to form partnerships with other companies--both domestic and foreign--in developing, designing, and marketing products. Technology moves so fast today that alliances may be the only way to stay competitive. At Battelle, we have a joint venture with Nippon Telephone and Telegraph and Mitsubishi Corporation in which we formed a company in Columbus dealing with a very sophisticated opto-electronics technology developed by the Japanese. We often hear of American ingenuity being put into practice by the Japanese, but this is a fine example of us bringing Japanese technology to the U.S. to make it available here.

Another example of the value of partnerships is in the area of developing high-speed passenger jets for early in the next century. The costs for developing such a plane are so high that it will require a world consortium to make this plane a reality. Three years ago Battelle formed the Center for High Speed Commercial Flight to act as a catalyst to bring together 25 companies from the U.S., Europe, and Japan--airline and freight companies, airframe manufacturers, engine makers, and financial sources--as well as government representatives. We are now very close to launching the first research stage of this tremendous undertaking.

Our government began taking steps to foster this type of partnering effort several years ago by rolling back antitrust laws related to research and development. However, since that time, many firms still are unwilling to form long-term partnerships. Certainly, some antitrust laws continue to inhibit this type of partnership, but the problem extends into the culture of our business relationships. Our government can set the stage for increasing American competitiveness by encouraging the formation of such partnerships.

The federal government should step to the forefront in setting our national R&D policy, but state governments also should play a role in helping manufacturers--especially smaller firms--develop innovative manufacturing. Many states have developed programs for state-industry-university consortiums to improve industrial competitiveness.

Ohio's Edison programs and Pennsylvania's Franklin programs are good examples. Illinois also has a fine program. However, the small firms that need this technology the most can least afford the current investment to enter these programs. The small manufacturer is truly the backbone of American industry. The vast majority of manufacturing employment in this country is in firms with less than 200 workers. Competing can be a real struggle for these smaller manufacturers. They must be concerned with reducing the risk of failure, and as a result, they do not always want to be first in the technology race.

Government can help these small firms by providing the necessary incentives for them to invest in the long term, and especially by reducing risks by fielding demonstration and development programs. They must have incentives to participate in programs like Ohio's Edison program, and in other trial programs that bring innovative technology to the shop floor. Certainly, our National Labs have a role in this scenario, as do our universities. It is the collaboration among industry, universities, and government that will provide the technological edge for American manufacturing.

In concluding, I would like to reemphasize that U.S. manufacturing firms have begun to realize what they must do to stay competitive. American industry is producing world-class products and is competing effectively in the world marketplace. But they must use technology wisely and work smarter in order to compete tomorrow. Our economic--and military--well-being depend on the strength of American manufacturing. Without innovative manufacturing processes, the U.S. will find itself unable to produce the consumer products and defense systems that will be designed over the next several years.

The primary responsibility for facilitating the foundation and stimulation for our manufacturing resurgence rests with the government. Our firms must have the incentives to invest in the long-range future. Our country must, as most world governments have discussed, have a national strategy for providing those incentives.

Thank you.

Mr. STALLINGS. Thank you, Mr. McConnell.

This third panel has been very interesting to us. You add a different element than we have had in the other two panels, that is the private sector, the for-profit and not-for-profit sector.

According to statistics, we discovered that the private sector, particularly this mid-America region, invests heavily in research and development. In fact, about eight times of the federal R&D funding.

It is very encouraging to see this kind of concern and investment in research.

Mr. Fawell, would you like to begin the questioning?

Mr. FAWELL. I gather that in regard to all of your testimony, there is a feeling that government ought to be involved basically in basic research, if I hear you correctly.

Obviously, government is there and ought to be there. That is important.

On the other hand, when we start going into applied research as has been indicated already, that may or may not be under the jurisdiction of this committee, but I gather that what I hear, Jack, you saying, and others, too, is that whereas we are indefinite there, what we are saying perhaps is that long-term, what I would call long-term high risk of applied sciences, is something that, in this day and age, global economy, etc., the Federal Government funding ought to be there.

Does anyone disagree with that?

Dr. HUNSINGER. Well, I would like to make a comment on that.

I believe that the issue of transferring long-term high-risk technologies is an issue of risk management. If you want to make a commitment right out at the front end to go all the way, the risk reward ratio is just out of question. You cannot—there is no way you can put a return equation on it to make it a good business deal.

So, I believe that the——

Mr. FAWELL. Excuse me. In your example, did you not indicate a perilous course, but you have kind of tracked your way through that wilderness, have you not?

Dr. HUNSINGER. That is true, and that, I believe, is where the government can help.

There are some real severe impeding factors that I am sure most of you do not even know are there. For instance, we have now gathered in our effort to develop this technology approximately $30 million of DOD R&D funds. Something that probably not many people know is that we are liable to return those dollars once we start producing parts, and, so, when we go out to try to get private funding, this little-known clause has to be included in our financial statements. I had a $30 million overhanging on liability against my financial statements.

Now, did you know that was there? I did not know it was there when I signed up for the contracts. Those are things that, in all likelihood, do not even bring any revenue in, but they were put there for a completely different purpose, the purpose I do not want to get into now.

Nonetheless, they make it very, very difficult in the private sector to fund on the transfer of technology because you cannot bring the private dollars to match the public dollars effectively.

And there is another area. The investment credit or the R&D tax. For a big corporation, this is very useful and it can be used for any accounting definition of R&D. It is expensive to the government because, and Norm will not like what I say possibly, but any—I mean, you can use it in very large quantities if you have big cash flows and use it to offset your taxes, and it does not even have to be for high-risk research, it just has to be for the accounting definition of research.

Whereas, with a small S corp, it becomes a—it shows I am not a tax man. I have my financial guy here to tell—give these terms, but it becomes also a—I will think of the word in a minute. The alternative tax credits, and, so, they cannot even use it.

So, for the purpose that the R&D tax credit was meant to stimulate and that is high-risk research, it becomes inoperable, and, so, this is a case again where the government could change those rules, actually decrease their costs to R&D tax credits, and focus it for what we really mean to do, and that is to transfer the high-tech or the high-risk research results into useful products.

Mr. FAWELL. So, what everyone is agreeing is that the Federal Government must have a financial part to play here, and I am interested in, Dave, IITRI's position and Battelle's.

Here you have a not-for-profit corporate entity involved in attempting to bring about this technology transfer. You are saying, too, though, that it cannot really be accomplished without federal funding.

Again, I am talking about high-risk long-term type of applied science, and I think that is what we are all agreeing to, is it not?

Dr. MORRISON. I think that there are definite areas that the industry cannot afford. I am not sure I would put the high-risk label on them because I am not sure that the risk is terribly high.

Take the example of sensors, which are sort of the eyes and ears of any control system, and I believe the gentleman was talking about NCMS and the need for tool measurements or control of manufacturing processes. Talk about chemical plants or bio-chemical plants or almost anything has a sensor in it, yet the market is so small for a sensor company, it is very difficult for them to develop a new product line because they cannot recover the costs of development because the number they make is so low.

Yet, it is a generic problem across a whole variety of industries. Industry, on the other hand, is at the mercy of the suppliers, and if the supplier happens to be in the ultra-sonic sensor business and you have a problem, everything fits an ultra-sonic sensor, whether it should be optical or radar or something else, so, you are at the mercy of the supplier, and that is an area where I think that there can be benefits from federal funding on a generic area.

I would not necessarily characterize it as high-risk. It is really a generic technology that cuts across a wide swath.

Mr. FAWELL. I guess what I am leading at is because global economy is here, it is not going to go away in the future, and we have always basically looked at long-term basic research as being something that only the government can do, and we cannot really expect free enterprise to be doing that, what we seem to be saying is because the changing times in which we are living, the past changing times and the global economy, that we are introducing a

new point, that applied sciences are going to need more help before we do the implementing.

Mr. McCONNELL. I think probably the most germane point of that has been made in the area of risk reduction. Basically, we live in an environment where even the venture capitalists, the entrepreneurs, is looking for a return in a reasonably short period of time. Just as time domain for introducing new products have come down, the time domain for which a financier wants to see a return is getting shorter all the time.

I think as a consequence, what we find is that we have some examples that have come out of Battelle recently. We have recently formed a company called Geosafe. It is primarily geared towards insitu vitrification of wastes that are in the ground. It is developed at our Pacific Northwest Labs. It had seven years of DOE support because of its application for the Hanford site.

Today, we are struggling to take that technology into the marketplace because the financial community still sees that as a very high-risk for their money compared to getting into a financial operation.

We are much more key today, I think, to money, to businesses that are keyed to exchanging money than we are to businesses that are key to developing technology.

Mr. KNUEPFER. I have spoken before to the need for what I consider basic research, but I, in addition to my capacity as chairman of the County Board, am in the machine tool business, and our institutions are simply not the same.

I have been buying in Germany for years simply because American manufacturers, for whatever reasons, did not in the kind of machine tools I buy—were not able to keep up with the technology.

The Germans have two institutions, one a private company where you do not have to make a profit, and, secondly, and I am not recommending—I do not think this is appropriate in American technology. The second company I have been doing business with has been effectively broke for years, but subsidized by the Deutsch Bank on the grounds that it is an important technology to the country, and they produce a good machine tool.

In spite of this, I think essentially that we have really to deal with the basic research need and leave the application as much as possible to the private sector.

The dilemma we get into is in two of the institutions which have been here today, which is the chip technology and the machine tool technology, eventually, we get so far behind that we then have to deal with applications technology rather than simply the basic research that I think is more appropriate for the role of the Federal Government.

Mr. WADE. Congressman Fawell, I would respond by saying that I think your fundamental premise has validity.

I think in the applications area, though, the comment that I believe was made by Egils earlier is terribly important, and that is, to differentiate between the technology push thrust and a market orientation pull kind of thrust.

I think to the extent that we can build marketplace incentives, market understandings and an ultimate customer orientation into

the way we design the incentive systems and the R&D apparatus, I think it will serve us all very well.

So, I would definitely slant in that direction.

If I could take a very micro view for a moment in my own industry, in my own company, we are not even allowed to be in manufacturing because of one of the basic restrictions imposed under the current consent decree agreement.

My judgment is that if we were allowed to be in manufacturing, to engage in a series of joint venture kinds of opportunities with manufacturers of telecommunications gear, ranging all the way, by the way, from software, which is defined today by the Federal District Court as part of manufacturing, to fabricated products, that we would all put our hands out and say, clearly, that is a manufactured product.

I think a significant difference would be made in this country and I think the importance of the telecommunications infrastructure is, in fact, part of the infrastructure of this country in terms of commerce and competitiveness, is an area that has been very badly overlooked. I do not think that is well understood.

Thank you.

Mr. FAWELL. I do not want to take up all the time. Just one question and then I will sit back for just a little while.

But, again, Dr. Hunsinger, I was very interested in your initial comments that you spent a good portion of your life in attempting to, even within industrial labs, to be able to bring the R&D, if I heard you correctly, over into the manufacturing aspects, and you were having trouble much as Mr. Bomerie and IBM had to go through, and then you said it was—you had experiences with the University of Illinois in attempting to push, I suppose, technology transfer on into industry and again more problems.

Could you just give us some of those—I guess I am getting to the point again, who is mostly at fault?

Dr. HUNSINGER. Well, I believe that it has to do with the two different kinds of people who do research or the difference between the person who does research and a person who is making the product or the product manager who is kind of a businessman.

I find that they have a very hard time talking to each other, and, so, the proposal that I made in my written testimony is that we make an industry out of companies or small companies or big companies, I do not care, but whose specialty is to be an interpreter, almost like a translator——

Mr. FAWELL. Is that not IITRI?

Dr. HUNSINGER. That is why I say, I have a very narrow view of the world. I see it from the far company doors, and those do exist. They are important, and at the University of Illinois and at Magnavox and at General Electric, that was needed both in the company to transfer the technology and it becomes a more difficult problem, of course, when you are talking about a fundamental research organization and a private organization.

Mr. FAWELL. So, I guess we in Congress might—again, that word comes up continuously, cooperativeness. To have competitiveness, you have to have cooperativeness. To have cooperativeness, you have to have good will that people can get along, understand, empathize with each other, and maybe culturally, Japanese—they

always come back into play, it seems, are better able to do this, though I keep seeing the bright light of U.S. business adjusting and acclimating and seeing that all of this is so.

We keep hoping, I guess, from a congressional viewpoint, when you talk about competitiveness, that American business knowhow is going to catch on and you will not need our funding as much, of which we have not a great deal.

Dr. HUNSINGER. Well, I would like to add one sentence. There has been an awful lot of negative things said here today. We should be proud of ourselves because we do a lot of things right as well.

Once in awhile, I get tired of hearing that we do everything wrong——

Mr. FAWELL. Yeah, I agree.

Dr. HUNSINGER [continuing]. And the other thing is it is a lot better than it was 10 years ago. Much better.

Mr. FAWELL. And I read an article in the Wall Street Journal recently and it talked about Japan's problems, which are growing. Their labor costs are greater than ours now, lo and behold, and they have—they are going offshore. They are building in America. They are investing in our infrastructure. I do not think that is necessarily as bad as some people think, if they want to rebuild America, they cannot take it back home very easily, and, so, it is an ill wind that blows no good, I guess.

Dave, you looked like you were going to pop with a question yourself?

Dr. MORRISON. I was just going to second what Bill said about there are a number of good things that have happened. Certainly, the change in the anti-trust laws from a research institute perspective has been a positive step. Second, the change in the law that allowed us to take title to inventions made on federal projects has given us another arrow in our quiver to go out and bring to industries the technology that they need. A company can now have protection if it wants to invest the money to go forward in the development of the technology. A third just happened. I think it was in the Trade Bill, that not for profit institutes are now included with the universities as a part of the ability to get funding from NSF for facilities. This means that capital does not have to totally come out of our earnings that we get every year.

There are a lot of things that Congress has done that have been very helpful.

Mr. FAWELL. Excuse me. Just two more.

Why are there not more Battelles and IITRIs? I mean, from a not-for-profit viewpoint, you are coming in here and you are being the broker and the middle man to help. You are in here helping internationally, I gather, especially Battelle. I think all of this is sound, but there are not too many of you, I gather.

Dr. MORRISON. Of the larger ones, there are only about seven of us. A few have disappeared from the scene, like Franklin Institute, which was one of the older ones that was eventually bought up in the private sector.

Mellon Institute, another one, was incorporated totally several years ago as a part of the university and now does not stand as an independent.

There have been two periods in which research institutes have been established. The early ones, Battelle and IITRI, were founded well before World War II. We obtained support of our business from industry. There was really very little government funding prior to World War II in terms of research and development.

Then, right after World War II, a half a dozen institutes were formed with a regional economic outlook. These included the Midwest Research Institute, Southwest Research Institute, Southern Research Institute, Research Triangle Institute, and Stanford Research Institute. There has been a third wave of institutes over the past five or ten years. Cities and states discovered that they needed to have some catalyst to help local industry, A number of approaches have been taken to address this particular problem. Generally, new research organizations have been established either within universities or a coalition of organizations such as the Minnesota activity that was talked about this morning.

Mr. FAWELL. In fact, these partnerships are sort of rebirths.

Dr. MORRISON. I think they are. They are very much a renewal.

Mr. FAWELL. Just one last question, Bill. You mentioned the foreign people who are knocking on the door and wanted to come in. Why did you not accept—you apparently turned them down.

Dr. HUNSINGER. You are trying to get me in trouble, Congressman.

No. I—there is a significant amount of interest and it is tempting, but I did feel that was not the way we wanted to do our business.

Mr. FAWELL. Thank you very much. I appreciate your testimony.

Mr. STALLINGS. Mr. Schiff?

Mr. SCHIFF. Mr. Chairman, I just have one matter to go into.

There were several references to the amount of money proportionate R&D that this nation devotes to the Department of Defense and defense-related R&D. Allowing for the fact that we need a strong defense, I am kind of curious from a commercial point of view if defense R&D provides and has provided in the past and can be expected to provide commercial spin-offs.

Now, I do not mean simply contracting with the DOD to produce defense-related equipment or whatever. What I am talking about is from a commercial and an economic competitive point of view, is investment in the DOD just a loss cause or is there some reasonable portion that we get back to that? For whomever.

Mr. MCCONNELL. I think the argument on advances is that there is a number of innovations, whether it is from microelectronics on down the line, that are flowing into the commercial economy.

I think it is partially a question of the balance within DOD in terms of what the initiatives are. There are some initiatives ongoing now in DOD in the area of initiating concurrent engineering practices on American weapons systems, on total quality deployment strategies, which I think will tend to wash back down much as the reliability center at IITRI has had an impact on industry.

But I think it is a balance between the two that comes into play. We also have some very sophisticated weapons systems, whether it is the stealth bomber or some of the more advanced electronics, which are well out in front of application in the commercial or industrial environment at this point.

So, I think it is a question of balance between both the innovations that are required to develop qualitative superiority in the weapons systems with the innovations required to produce them reliably and efficiently.

I guess it is in the latter category that I think we will see greater gains in industrial competitiveness worldwide.

The alternative is that new technology evolves and the next thing you know, we will be buying it from Japan or Korea along the way.

Mr. MORRISON. I would just add, it is my opinion that there is a large amount of spin-off from the defense R&D. Sometimes we do not recognize the idea originated or the concept originated, but at least from my own organization, I can see several things that had their roots in defense. For example, since this subcommittee deals with energy, we have developed, patented and are now licensing a process using radio frequency energy for heavy oil recovery that can be applied to oil shale and tar sands if we need them again in this country.

The basic inventors of that process got their start in the defense business on radar and antennae modeling and looked around during the energy crisis in the early 1970s for how could that technology base be used to solve the energy problem.

The same technology also transitions into the hazardous waste problem. I mentioned the subject of sensors, and again, I think that is a virtual untapped area that the Defense Department has invested huge sums of money. In fact, I said during the Star War days, if we could detect a launch from 25,000 miles in space and determine whether it was a real or a decoy that was being launched, we sure as heck ought to be able to get to the manufacturing floor and detect something about a millimeter away.

I think there is room for that technology, but it takes a lot of effort to get industry on board, to see that there is an application there from defense research.

Dr. HUNSINGER. This is my business, so I would like to make one more sentence. I know I have been talking way too much.

Yes, I think there is a dramatic amount of spin-off at least in the electronics area where I work. I can look at—I am a technologist and I can go down and look at the photographic processes and many, many of the electronic component processes and you trace their origins back, you will find Dartmouth or one of the defense agencies had really the main thing that got them started because they will take the high risk.

In our case, they were the only people who would look 5–10 years out to develop something that had a big kick, but they would take that risk, and they are the only people that would.

There is a slight negative side in the sense that they have become paranoid because of all the unfortunate things that have gone on in the contracting business, and, consequently, from military-critical technology issues, they are afraid to become—to let things out when they are public knowledge, because nobody wants to sign their name to it.

So, we cannot sell it. Somebody else can read how to build it from things that are in the open literature and manufacture it in their country, but we cannot sell it. Those kinds of things which

are kind of procedural, and that is the things that I was talking about that the Federal Government can do, you can comb through those procedural things that really do not buy much for our country, in terms of protection, and allow the growth of the technology to flourish, and that is what I think is more important than actually dollars, is those kinds of regulatory things that are handcuffed, and they were put there for one reason or another, and they are just there and then they go out and stop things.

Mr. SCHIFF. Mr. Chairman, just one quick observation, and that is, I regret in a broad sense that this nation is compelled to have a strong military. I think that remains a necessity.

I am of the opinion, I have to admit as a layman, just coming into this, though, I am of the opinion that there can be a great inter-working of scientific development and information between military needs and commercial needs. I think there has been, and I think there can be a great deal more in the future.

Thank you, Mr. Chairman.

Mr. STALLINGS. Thank you, Mr. Schiff.

Let me just pose one problem and get your advice.

This country goes through different phases in terms of research, both at the national level and at the private level. Mr. Wade, I assume the Bell Companies spend a lot of money on research on telecommunications issues. You do not get much beyond that, although probably you do some.

So, companies, whether they be steel or chemical, will spend a great deal of research to enhance their own companies, to enhance the profitability of those companies.

On the other hand, the Federal Government will spend research dollars on trendy kinds of things. In the 1970s, it was on energy. You mentioned shale and you mentioned the other types of ways of extracting energy from the earth.

President Reagan sent the research dollars towards space through the SDI Projects, and, so, for ten years or eight years, we spent several billions of dollars in that area.

We will always be spending money on research for military applications. That does not—I do not think any of those get into the kinds of long-term, really long-term R&D that you were referring to. At least my impression is that we are looking for something that will take us into the next century, that will do a number of things, which may not be defense-related or may not be energy-related.

We on this committee spend or direct funds to energy-related kinds of research. When you talk about long-term R&D, when you talk about the not so much goal-oriented as Star Wars system or immediate return for energy research, how can we determine where we ought to spend our money? How might we in the Congress—now, you need to understand that unlike your businesses, Congress reacts to things. We wait till there is a crisis, whether it be an energy crisis or something else, then we get in a big hurry and we pass something through and then we beat our chests and say we have done that job, let us get on to something else.

We are doing that AIDS research right now. Spending billions on AIDS research. Give me some ideas of long-term research. Give me some ideas of directions of how we in the Congress can determine

those directions and then convince our constituents this is really a good place to spend money over the next forty or fifty years.

Mr. WADE. Mr. Chairman, first, let me correct something that I think was in your mind when you posed the question about drug companies.

We do, in fact, spend a great deal of money on purchasing systems, purchasing components. As I said, we are prohibited strictly from manufacturing. We cannot manufacture anything that relates to our business. That seems perverse, I am sure, and I think it is very perverse.

But as a consequence of that, we do not have the kind of a research and development capability you might expect to find in DuPont and General Electric and IBM and so on, partly as a result of that.

We do, however, indirectly fund a great deal of R&D in the information and the telecommunications industry through the purchases we make from AT&T and IBM and NEC and Northern Telecom and a host of companies around the world.

On your more global question, it seems to me that one thing Congress perhaps might do more than I sense you do is to spend a bit more time on where the best minds in this country suggest this country is, in fact, moving.

I think if you look historically, most people would agree that we have gone through a series of phases as a country. We started certainly with an agricultural economy, maybe even a phase before that, moved through an industrial phase. We are perhaps now somewhere into the information industry or cycle phase.

I think it would be time well spent for the Congress to engage in having futurists explore where we really are moving, what is the next phase the country is moving into, and what are the high priority R&D investments that that suggests as you look ahead, not just a decade, but two and three and five decades.

It is suggested that it is blue skying, but I think some of that is perhaps time well spent, and there are some minds that really are going to explore this deeply, and I think that it would be useful.

Mr. STALLINGS. Any others? Yeah?

Mr. MCCONNELL. I think one of the things that we have observed, particularly with those of our colleagues that work in the Pacific Northwest Labs, is as the weapons-related mission of some of the DOD labs have been declining, we have seen the direction of additional attention to some of the other issues, whether they are global-environmental issues, industrial competitive issues, and out of that comes the sense that there are some very fundamental driving issues that are going to permeate life in the next several decades, and they range from the more current pieces in terms of information sciences and its application and the like, and it does not take too much imagination to see where that might lead us in some of these areas.

There are some in human health and environmental development, particularly, which I think are fairly acute cases. We have got some examples of that today. The most recent EPA report, for example, indicates that the future direction of R&D in EPA is towards human health effects from environmental pollution because

there are far more effects than we previously suspected to see in some of those areas.

I think if you look at global trends in terms of industrial competitiveness, in terms of need to bring products to market faster, more production for specific markets and so forth, you will see some elements that seed out there, and I think you have heard some elements that have popped up today in testimony I have heard this morning as well.

So, I think if you map some of those trends, some of the national labs are now looking at things ranging from infrastructure modernization all the way on through human health as issues which are critical in the future, and they are far enough out that it is difficult to get most of American industry to invest very much in that at this stage in time, and I think coming back to your point, cooperative effort between the labs, between industry, and the universities at that point really does begin to show a payoff in the long-term, in terms of stimulating that base of technology.

Mr. STALLINGS. Please, go ahead.

Dr. MORRISON. I was just going to try to respond to your general question, which was, indeed, a very difficult one to answer. How you go about setting some sort of priorities and decide what the government should do.

I think, ultimately, you are going to be judged by the marketplace which has these swings, whether it is environment today, energy tomorrow, space the day after that, whatever. I think some insight comes from some of the more recent thinking on the process of innovation.

It seems to me for many years, we were driven in this country with the idea we took a basic research result and then we put it into applied laboratory. It then went into a pilot plant where more data on process parameters were obtained and you started to get a little bit of data on the economics of the process. It then moved into at least partial production and then finally into production.

It was a very linear process and it took twenty years, all the historic studies seem to have that time horizon.

It seems to me that what is emerging from these studies is that the process is a very random one. What you are really dealing with is a knowledge base. For example, if Bill's production manager has a problem, he may not need to buy new technology, but he does need some knowledge. He does not really care who has the knowledge, whether it is in his own company or whether it is in a government lab or a research institute or university or sitting on the shelf in a paper somewhere. As long as he can find the knowledge, he solved his particular problem. It would come from any of the various stages in the innovation process I previously described.

If there is no knowledge available, then it has to be developed. We really must sustain basic research which supports the education process as well as expand the science base in this country. We have heard that several times during the day.

If we lose our trained manpower, we will not be able to apply what we know how to our problems. Simultaneously we have to have a science base which expand over time.

A second area which I think is probably given short shrift by government is, phenomena-related or process research. The Defense Department characterizes it as 6–2 research.

Basic research of 6-1 funding is relatively easy to sell because it is good for you. It is something you ought to have and budgets for it have been expanding. But if you look at what has happened to the 6-2 budgets, even under the increased expenditures by the Defense Department, that has probably gone down relatively on constant dollars rather than going up, and that is the area where you try to understand what would be a practical application of the best of technology, and the determination of what will really work.

There is a whole lot of phenomena that are involved such as, mass transfer and materials problems. Very little research is done on means to build a better heat exchanger. For example, we have numerous industrial processes that need heat exchangers, and heat exchangers are generally not very efficient and yet, that is a very generic kind of problem that requires process-phenomena-oriented research to solve. Such research is not being done by the commercial sector. I would suggest that Congress take a look at the government role in phenomena and process-oriented research.

Such research is not long-range and really basic. It is also not near/term with the pay off in two to three years that industry is looking for. It is something in the middle ground that would benefit from expanding support by the federal government.

Mr. STALLINGS. Thank you.

It is a frustrating and an exciting world to be part of. We see this information, I guess, pour into the public domain. It is rather frustrating when you think that we are spending millions and billions in research and a few new developments can render a lot of that obsolete. A few changes and, all of a sudden, we are into a brand-new phase of this development as you have pointed out so eloquently, and almost start from scratch again.

It is a fascinating process.

Mr. Fawell, do you have anything else you would like to add at this point?

Mr. FAWELL. Just one point. I did not mean to overlook it. I think, Mr. Wade, your comments were excellent in regard to the service industry. All applied science we talk about is always in regard to manufacturing products, and we do forget that a great part of our GNP, I think you said roughly two-thirds, happen to be service, and we assume that productivity will always be increasing there and you are quite right, I gather, that it is not.

I think I once had a conversation with you or at Illinois Institute where someone suggested that you do an awful lot with increasing the productivity of the United States Post Office, that we could just revolutionize things if we would just set our minds to that.

Mr. WADE. Which, by my definition, is part of the service sector.

Mr. FAWELL. Yes.

Mr. WADE. The only other point I would make is that, in fact, our global competitors are investing very heavily——

Mr. FAWELL. Yes, they are.

Mr. WADE [continuing]. In service sector type productivity. So, it is not an issue that we can ignore.

Mr. FAWELL. I guess the layman would say, well, why is not business in there and doing that. Does government have to help fund that? We always ask questions, well, is it selfish. Big business in this country interested in short-term quid pro quo and worried about raiders and things of that sort. So, you have to, you know, deliver for the stock market and, thus, we do not think in terms of R&D and things of this sort. The Japanese look more to long-term profits. They have that kind of a thing.

But you are convinced that this is an area that does need government intervention in terms of grants to get us up and going in that area, and I assume that that is the case in other countries?

Mr. WADE. I think clearly it is another one of these areas of joint enterprise. I think clearly the mission has to be driven by the private sector, but I think there is also clearly a need for government involvement in education, in some seed grants, to create these centers of competence that I talked about.

So, I think, as in most cases we discussed today, it is not a single focus. It is a collaborative effort that will produce results, I would think.

Mr. FAWELL. Thank you very much.

Mr. STALLINGS. To the panel, we thank you for your comments and your testimony. They will be made a part of the official record and we will share these with our colleagues.

Mr. Fawell, I appreciate your invitation to join you here in Illinois.

This has been a most interesting and valuable hearing for me. Again, as I said earlier, we in Idaho are looking for as much as we can get in the way of expertise, and I will share your testimonies with our people to see what they can acquire from it.

To the folks that stayed with us through the entire session, I appreciate that. Sometimes these sessions can be long, but I think the information is very valuable.

So, with that, we will adjourn the Chicago hearing of our Subcommittee on Energy, Research and Development.

[Whereupon, at 4:05 p.m., the subcommittee adjourned.]

APPENDIX

ADDITIONAL STATEMENTS FOR THE RECORD

FEB 09 1989

NALCO CHEMICAL COMPANY
ONE NALCO CENTER ◦ NAPERVILLE, ILLINOIS 60566-1024 ◦ AREA 312-961-9500

February 9, 1989

Congresswoman Marilyn Lloyd, Chairman
Sub-Committee on Energy Research and Development
Rayburn Building
Independence and South Capitol Street,S.W.
Washington, DC 20515

Dear Congresswoman Lloyd:

We at Nalco Chemical Company would like to thank you and the members of your Sub-Committee on Energy Research and Development for taking the time and effort to conduct this field hearing on science and technology priorities and perspectives in the Mid-America region. We are sorry we are unable to attend the hearing, nonetheless would like to offer the following comments for your consideration.

Nalco Chemical Company is located nearby in the important and growing East-West Technical Corridor. The company is a world leader in the manufacture and supply of specialty chemicals. The Company's products and people serve the needs of oil producing operations; refineries; pulp and paper mills; the institutional market; metalworking; mining and mineral processing; municipalities; the food and beverage industry; the automotive and transportation market; and the plastics industry. The Company strives to solve industry problems through the innovative application of a broad range of chemical technology. Industry needs typically include water treatment and water clarification, pollution control, energy conservation and process efficiency. Worldwide sales were approximately $1 Billion in 1988 through operations in 130 countries. Nalco placed 354 in the 1987 Fortune 500 ranking of U.S. manufacturing companies.

As you can see, Nalco is very technology dependent; in fact, our very life blood and future depends upon it. What's more, we at Nalco are a part of the third largest industry in the United States and one of the few that has a large and growing positive balance of payments. Much of what we and the world enjoy today in the way of our modern standard of living is the result of chemical technology. However, a major threat to this otherwise rosy picture looms on the horizon; that is, an impending shortage of technically qualified scientists and engineers in this country. Let me share with you a number of our concerns.

- Continued -

1. The National Science Foundation projects a cumulative shortfall in holders of BS degrees in natural science and engineering of 430,000 by the year 2000. Based on current trends a shortage of 8,000 PhD's in this field will occur by 2004.

2. The number of new doctorates in the basic sciences seeking academic positions over the last decade has decreased by 50% in chemistry and 45% in biology.

3. In 1980-81, 49% of engineering doctorates went to foreign students. A 1986 report of the Office of Technology Assessment stated, "there are more and more foreign nationals in graduate schools and among faculties. We need to get U.S. students into graduate schools and keep U.S. PhD's in academia to teach new students."

4. An increasing number of Americans possess insufficient knowledge and understanding of scientific principles to enable them to provide "informed" participation in the formation of public policy in science and technical matters.

5. Less than 2% of doctoral degrees in the physical sciences and engineering are awarded to Blacks and Hispanics, yet these minorities will comprise one-half of high school students by the year 2000.

Two Nalco examples provide early insight into the consequences of these trends. The first involves one of our senior chemists who participated in a career night sponsored by one of our local school districts. High school students had the opportunity to learn about careers in over 50 different fields. Of the 500 students who attended this event; less than a dozen inquired about careers in chemistry. The other example involves the hiring of individuals in one of our important, high technology laboratories. Our Vice President in charge of this area reports that of the three individuals hired in the last five years, two are Korean and one Chinese. As you might expect, work permits, language, and family considerations complicated the adaptation and utility of these individuals within the company.

- Continued -

Why is Nalco so concerned about the apparent trend away from science and chemical engineering?

- We have a 60-year tradition of progress and growth; continued growth requires an uninterrupted supply of science talent.
- We are operating in an extremely competitive and complex world, where industries can vanish due to a national weakness; our survival requires new, aggressive, and plentiful science talent.
- We in the chemical industry are increasingly dependent upon public perception and those in government; we need a scientifically informed citizenry if we are to resolve problems and be treated fairly.

We would appreciate anything you can do to address this educational trend away from the sciences so that we and others can be assured of the science talent to grow and develop our company, industry, and country. Perhaps we need a specific federal program or goal to rekindle the American interest in Science, much as our effort to put a man on the moon did more than 25 years ago.

Thank you for the opportunity to make these comments, Congresswoman Lloyd. We would be happy to amplify upon them if you wish.

Very truly yours,

Graham H. Jackson

Graham H. Jackson
Director, Government Relations

GHJ:eas

cc: Congressman Harris W. Fawell

AT&T

February 17, 1989

The Honorable Marilyn Lloyd, Chairman
Subcommittee on Energy Research & Development
Committee on Science, Space and Technology
U.S. House of Representatives
B 374 Rayburn House Office Building
Washington, D.C. 20515

Dear Madam Chairman:

Thank you and Congressman Fawell for providing AT&T the opportunity to file a statement as part of your field hearing on Science and Technology priorities for the Midwest at Argonne National Laboratory on February 10, 1989. I submit the attached statement and respectfully request its inclusion in the record of this hearing.

Sincerely,

Attachment
As stated

Statement

of

KARL E. MARTERSTECK

Executive Director
Digital Switching Systems Division

AT&T BELL LABORATORIES

SCIENCE AND TECHNOLOGY POLICIES FOR THE MIDWEST

Presented

to

The Subcommittee on Energy Research & Development

of

The Science, Space and Technology Committee

U.S. House of Representatives

Field Hearing
Argonne National Laboratory

February 10, 1989

My name is Karl E. Martersteck and I am Executive Director-Digital Switching Systems Division at AT&T Bell Laboratories, Naperville, Illinois. I am pleased to have this opportunity to offer a statement on behalf of AT&T Bell Laboratories and on behalf of our parent company, AT&T.

Let me commend the Energy Resources and Development Subcommittee Chairman, Ms. Lloyd, and Congressman Fawell for conducting this hearing. The topic, Science and Technology Priorities for the Midwest, is an important one.

AT&T is proud to be one of the largest corporate employers in the Chicago area and in the State of Illinois, with more than 23,000 employees in the state and more than 13,000 in DuPage County alone. Those numbers include a strong research body. AT&T Bell Laboratories at Indian Hill employs nearly 7,000 people, many of whom are scientists and engineers, and AT&T's Network Software Center in Lisle employs close to 2,000 people.

Establishing priorities in science and technology is a matter of great importance to the entire nation, because the policies and programs that result from these priorities will dramatically affect our ability to compete in today's highly competitive and increasingly technology-driven economy. Setting priorities is, nonetheless, a complicated and difficult process in our democratic, free enterprise society, where individual researchers, corporations, public and private universities and laboratories, scientific and professional organizations and associations, and various state and

federal government bodies all have distinct and often differing views. In spite of these differences, however, I believe that many in the science and technology community agree on a surprising number of issues and that most would agree with the bulk of my statement today. Accordingly, the views offered in this paper are my own but reflect priorities widely recognized and supported by the nation's scientific and research community.

It is important to note at the outset that the very highest priority for both federal and state governments must be to assure the stability and predictability of our economy. Without the expectation and the confidence that the economy will continue on an even keel, with a satisfactory level of growth, there can be no hope that American industry would risk investing capital in research and development programs whose fruition were off in some shaky and indefinite future. For the federal government, in particular, stabilizing the economy means finding a satisfactory way to begin easing the federal budget deficit, which remains a source of serious concern to industry and to investors. Decisive action by the federal government would greatly ease such anxieties.

At the very center of science and technology policy for industry in any region or nation are research and development. More and more industries, including telecommunications and information services, depend on research and development to remain competitive. Technological innovation comes about only as a result of heavy capital investment, and the products and services introduced today will likely be made obsolete in just a few years by new equipment and processes that will quickly come along. Companies which do not

invest sufficiently in research and development cannot hope to provide state-of-the-art products and services, and they run the serious risk of being left behind by competitors, domestic and foreign.

But research itself is a high-risk process. Its outcome is uncertain and unpredictable, often bringing greater marketplace benefits to companies other than the one making the major investment. AT&T continues to rely primarily on its own internal initiatives, and our commitment to basic research and development over the long term is fundamental. AT&T has funded such research consistently over many years through Bell Laboratories. At the time of divestiture, January 1, 1984, AT&T's assets were reduced by about two-thirds and some industry observers expressed concern that AT&T would reduce its investment in basic research. The Company said its commitment to Bell Laboratories would not change and subsequent expenditures have borne that out; in fact, Bell Laboratories is funded better today than it was before divestiture.

In our view, the industrial research and development process begins in the laboratory and extends without interruption right through to assuring that the customer is satisfied with the finished product or the service provided. Several years ago, for example, AT&T launched a program to bring technological advances, software technologies in particular, into its manufacturing and product distribution operations, an objective we consider crucial to any long-term improvement in productivity. The Company utilizes systems engineering to redesign, re-engineer and simplify plant organization and production and employ material resources and people more efficiently. We

also employ mechanization to improve and expedite the flow of information, which is such a fundamental part of the production and distribution operations.

Other major U.S. companies have similar programs under way, but American industry in general has been quite reluctant to invest in the innovation process for the long term, i.e., the fifteen to twenty years that it often takes to bring fundamental innovations to the market. Moreover, American firms have too often been unwilling to invest in new manufacturing plant and equipment. The result is that our manufacturing facilities and processes have fallen behind and U.S. productivity gains have for decades lagged behind those of some other industrialized nations.

Technology is a major strength of the midwest, as it is America's major strength at home and in the international marketplace, and government policies should encourage U.S. firms to capitalize on that strength. Tax policies that encourage more adequate funding of research and development are particularly important and should be considered a very high priority. The Economic Recovery Tax Act of 1981 recognized that enlightened federal tax policy could encourage corporate research by allowing companies an incremental tax credit for research and development.

The tax credit has helped R&D funding, but its effectiveness has been diluted for several reasons. It is not applicable to a sufficiently broad range of companies, it has not been enacted on a permanent basis, and it provides relatively little benefit for companies, like AT&T, which have a consistent, sustained level of R&D funding over many years. Another point,

although it does not affect AT&T, is that, for companies greatly affected by business cycles, as many companies in the midwest have been, the R&D tax credit in its present form has another serious shortcoming: it is not allowed as an offset to the corporate alternative minimum tax. It is thus an uncertain credit for companies which may be subject to the alternative minimum tax, and this greatly reduces its value as an incentive.

Some have said that the R&D tax credit has not been demonstrated to have increased corporate investment in research in the years since it was enacted, but perhaps this is the result of the limitations just mentioned. The effectiveness of the credit would be greatly enhanced if the credit were made permanent, if it were extended to a broader base of companies, including start-ups and those with a sustained level of R&D funding, and if it were allowed as an offset to the alternative minimum tax.

The basic research credit, which gives companies a tax credit for funds contributed to universities for basic research purposes, is an important corollary of the R&D tax credit, and it too will cease at the end of this year unless Congress enacts legislation to extend it. We believe that this important incentive to funding basic research should also be continued.

Federal and state policies that enable American companies to cooperate in developing and sharing new technologies and introducing them on the market, and policies that foster cooperation between corporations, universities and government laboratories should be regarded as high priorities also. The Sematech venture, the National Center for Manufacturing

Services, as well as research on superconductors, supercomputers and high definition television are examples of where cooperation among large corporations with the support and backing of the federal government could prove beneficial. It is still too early to know how fruitful such efforts may be, but they offer considerable promise.

The greater part of federal research and development funds goes to federal departments for their own so-called "missions" or objectives, while only a relatively small portion goes towards more open or broad-based research efforts. Some of the latter efforts occur within the executive-branch departments but funding for most broad-based research comes through the National Science Foundation. In recent years, the NSF has initiated a number of programs to foster joint or cooperative research initiatives by corporations and universities. Among the first of these efforts were the Engineering Research Centers, begun under grants from the National Science Foundation five years ago. The NSF has played a significant role over many years in promoting and supporting university research in many areas, especially in the physical sciences, with results that have been beneficial for the institutions themselves, for business and industry, and for society, and the ERCs follow in that excellent tradition. They were designed to have a broad impact on academic engineering research and education, through cross-disciplinary research efforts focused on a range of activities important to technological innovation and economic competitiveness; they were intended to stimulate a dialogue and flow of information between universities and industrial research facilities by directing research toward current and projected industry needs; and thirdly they offer students a broad,

industrially oriented perspective and, more particularly, an improved understanding of the integration and management of engineering systems. Industrial collaboration in the ERCs is achieved through advisory bodies and through joint projects and educational activities. Corporations have taken an active interest in the ERCs, as demonstrated by the fact that industry contributes $1.24 to the ERCs for each dollar contributed by the federal government.

Two years ago, the National Science Foundation took a further initiative by launching the Science and Technology Research Centers Program. Complementary to the ERCs and other programs of the National Science Foundation, the STCs are intended to help maintain U.S. preeminence in science and technology and provide an adequate pool of highly skilled and experienced scientists and engineers.

The primary objective of the STCs is to exploit present opportunities in science and technology where the complexity of the research problems or the resources needed to solve these problems require large-scale resources, extended time, and equipment or facilities available only at a campus-based research facility. The STC program recognizes, in other words, that an increasing number of research activities are too vast, too costly and extend into too many diverse areas to be undertaken by individual scientists or researchers. Other important aims of the STCs are to increase the transfer of innovative technologies to useful social and commercial applications and to provide special educational opportunities for our future scientists, researchers and technical workers.

The future of the STCs and other federally supported research programs is somewhat indefinite at the moment because of uncertain funding. The science community, with support from industry, has called for doubling of the NSF budget, particularly in areas directed toward basic research. Congress has authorized sufficient funds for the STCs and other programs, but appropriations have been slower and more difficult. In view of the federal budget deficit problems, discussed earlier, Congress and the new Administration must look very carefully at all expenditures. But promising research initiatives have an important place among federal priorities, as this hearing should make clear.

I do not intend to suggest that the ERCs and the STCs represent a complete answer to science education and scientific research at our universities; they do not. Moreover, not all ERCs established in the last few years have been entirely successful. Nevertheless, the concept is sound and many cooperative-research programs, including those at the University of Illinois at Champaign-Urbana, at Northwestern, Lehigh, Michigan State, Ohio State and Purdue, have been highly productive. More must be done to enhance the status of engineering science at our universities and in industry, giving this science the same recognition and place that fundamental science enjoys. And, as I have tried to emphasize earlier, more incentives must be provided to industry to invest more readily in research and development--incentives such as the R&D tax credit and the basic research credit.

The National Science Foundation has requested additional funding for disciplinary research in certain areas, including materials research and high performance computing, both of which we consider particularly important.

Increases in funding for research in materials processing could have a substantial impact on the development of new superconducting materials, semiconductors and improved electronic circuitry and technologies. Research in high performance computing could result in breakthroughs that may lead to the faster development of the supercomputer, as well as advances in information processing systems, networking, etc.

One of the more formidable, but at the same time more rewarding, aspects of the research and development process is to take newly developed technologies and find practical applications for them in commercial or industrial use. A closely allied problem is that described as "technology transfer": taking technologies developed by government research and employed, most often, for defense purposes, and finding commercial, non-military applications for them. To some extent, these can be described as peculiarly American problems, because historically the United States has been more successful in achieving major technological breakthroughs than in bringing these new technologies to the marketplace. More than that, the U.S. spends nearly three-fourths of its government research money in the defense area, so it is particularly important that such vast research resources not be without benefit to other areas of society.

The commercial application of new technologies and the problem of technology transfer are particularly significant in the midwest, where the typical industry is represented by small or relatively small companies rather than by large corporations. These smaller firms, often second or third tier manufacturers, suppliers or distributors, have difficulty keeping up to date on new technologies without some incentives or help at the federal or state

level. The Omnibus Trade Bill enacted in the last Congress authorized the establishment of centers for technology transfer, to be set up in different parts of the country, but only three have been established so far, none in the midwest. More such centers are required, particularly in this part of the country.

In thinking about the technological needs of the manufacturing industry, particularly here in the midwest with its smaller companies, we must keep in mind not just of automated-machining challenges, but more broadly systems integration, process control, materials technologies, etc., improving the quality of products as well as making production more efficient and reducing costs.

Information sciences and technologies merit particular attention. Information sciences have had dramatic effects in administrative and management tasks in recent years, improving response time and efficiency, and affording people overall better and more satisfactory services in many areas, from health and hospital care to insurance and legal claims, travel, vacation and leisure activities. We need to devote more resources to this fertile area of information sciences and technologies in our increasingly service-based economy.

The practical application of technology is ordinarily best accomplished when the research, engineering and production processes are all done by one institution, when the application process follows quickly and directly upon technological development, and when the people involved are thoroughly knowledgeable and experienced in the broad range of processes and interact on

a one-to-one basis in the laboratory, in industry, or in state and local government. The close working relationships established in the ERCs and STCs and other industry-university-government cooperative efforts may help to alleviate this problem if the industrial partners find a serious stake in the enterprise.

Various legislation has been enacted in recent years to promote the transfer of technology--products and processes, skills and knowledge--from the federal laboratories to the private sector, but important constraints on such transfer still exist. Recent changes in the law allow federal laboratories to patent and exclusively license inventions, but federal computer software is public disseminated, with the result that businesses have no incentive to fully develop and market this software. Because federal laboratories typically cannot conduct proprietary research and must give anyone who asks access to research results, businesses find little reason to collaborate with these laboratories. Laboratories operated by corporations for the Department of Energy must petition the Department to waive its title rights to inventions made at the laboratories. Lastly, federal laboratories, in their attempts to be fair in providing research opportunities for business, sometimes institute costly and time-consuming red tape. Removing or reducing these remaining constraints would do much to facilitate the technology transfer process.

It is worth noting that financial or economic constraints are not the only barriers to more rapid and effective application and utilization of new technologies. There are important, often formidable, psychological and educational needs to be met before management and workers, customers and the

public feel ready to receive new technologies. More effort must be directed toward helping people understand and grow comfortable with new equipment, processes, products and services. Educational and training efforts should extend also to workers who have been displaced by new technologies with the objective of repositioning them for productive work and new career opportunities.

Although I have not focused at length in this statement on the importance of science and technology to U.S. competitiveness--an issue that receives much discussion these days--it has been mentioned and is certainly implicit in all that has been said. But one aspect of this issue must be addressed directly.

For the past several years, the Regional Bell Operating Companies (RBOCs) have sought to make the point that the line-of-business restrictions contained in the 1984 AT&T Consent Decree with the Department of Justice (also known as the Modification of Final Judgment or MFJ) destroy any incentive for them to engage in research and development. The RBOCs are particularly desirous of being allowed to manufacture telecommunications network and switching equipment, and customer premises products, and they argue that this would be a considerable boon to the U.S. economy.

In fact, however, just the opposite is true. Allowing the Regional Bell Operating Companies into telecommunications equipment manufacturing--a business closely allied with their local-exchange monopolies--would give them a decisive edge over any non-affiliated manufacturer and, so, would destroy

fair competition in this industry. Returning the industry to a structure characterized by monopoly telephone companies buying equipment only or principally from their own captive manufacturers would destroy the competitive communications equipment markets that have developed since divestiture. The manufacturing restriction on the RBOCs is based on voluminous evidence presented during the AT&T trial, and reaffirmed during the Court's first triennial review, in 1987, that the Bell companies could not be permitted to provide both "essential," or "bottleneck," local telephone services on a regulated-monopoly basis and closely linked competitive services without anticompetitive behavior occurring. The link between the local monopoly and the manufacture of telecommunications equipment was shown to be as close as that between local-exchange and long distance services, and the dangers of anticompetitive conduct equally great. As the federal court has found, none of those realities has changed since divestiture; the dangers of anticompetitive behavior are as real today as they were then.

There is intense competition in the telecommunications equipment market today, as many large U.S. and foreign manufacturers are moving more and more aggressively to try to win contracts with the RBOCs and other American telephone operating companies. The only way a manufacturer can succeed in this competitive marketplace is with state-of-the-art technologies and rock-bottom prices. Not surprisingly then, the intense post-divestiture competition in the telecommunications equipment market has encouraged R&D investment, spurred rapid technological innovation, and produced substantial price reductions for the telephone companies and their customers. Since 1982, R&D expenditures in the U.S. information industry have more than

doubled. AT&T's R&D is up over the old Bell System total. R&D investment of non-AT&T, non-RBOC companies is higher as well, dramatically higher. This increased R&D funding is exactly what the U.S. needs.

The resources represented by the RBOCs are by no means left out of today's marketplace; collectively they represent the largest customer body for network equipment in the world and their combined market justifies the R&D expenditures of telecommunications equipment manufacturers. Allowing the RBOCs themselves to manufacture would generate no additional investment capital for telecommunications R&D, but would harm existing manufacturers. The only potential source of any new capital in the competitive telecommunications equipment area would be cross-subsidization from the RBOCs' local-exchange monopoly ratepayers--precisely the kind of uneconomic and anticompetitive activity the MFJ was designed to prevent.

The MFJ permits the RBOCs to fund product development now. Manufacturers may contract with RBOCs to receive funding and develop products to RBOC specifications. Moreover, the terms for such RBOC funding permit an RBOC to have exclusive use of the resulting product or to receive royalties on the sale of the funded product to others, in order to defray the RBOC's up-front costs of funding; in other words, the royalties can fully recover the costs an RBOC sustains in funding the development of a product for their own use. The only thing the RBOCs cannot do is receive unlimited royalties on sales to third parties, which would obviously give the RBOCs a stake in the success of one manufacturer's product over another and thus provide an incentive for anticompetitive conduct.

Even if the manufacturing restriction itself were relaxed, RBOC-affiliated manufacturers would be in no better position to meet the needs to the RBOC operating companies than any other manufacturers. If an RBOC were to provide an affiliate favorable consideration with respect to equipment specifications or design or in any other way, this would clearly constitute anticompetitive behavior.

The RBOCs also suggest that allowing them to manufacture telecommunications equipment would help to make the U.S. a more able competitor in the international telecommunications equipment market. As the Huber report to the Department of Justice in late 1986 and the Department of Commerce both have found, allowing the RBOCs into the manufacture of telecommunications equipment would worsen rather than improve the present foreign trade imbalance. To begin with, developing a major switching manufacturing capability today requires huge R&D outlays. No country, including the U.S., has more than one such capability. For the RBOCs to enter this network equipment manufacturing marketplace, were they allowed to do so, they would understandably explore possible alliances with foreign manufacturers already engaged in the manufacture of such products. In fact, they have already set a precedent for such a course of action. Soon after divestiture, the RBOCs began building close ties with foreign manufacturers, and they have continued to strengthen those ties. The RBOCs regularly import a significant portion of their telecommunications products and equipment from abroad. There is little doubt then that, if allowed to manufacture telecommunications equipment, the RBOCs would do so through joint ventures with their foreign partners and they would then purchase their equipment

exclusively from their foreign-based affiliates. Such joint ventures could foreclose the market not only to AT&T but also to the hundreds of small American manufacturers which currently sell their products to the RBOCs.

Such joint ventures abroad would hardly be financed by the RBOCs without full-scale involvement in the R&D processes required. That would undoubtedly require that the RBOCs fund the scientists, researchers and technicians in various foreign countries to engage in such R&D. Funding for American scientists and technicians would surely be reduced. It is hard to envision how such an exportation of R&D funding could do anything other than further handicap the U.S. in the international marketplace. In sum, allowing the RBOCs into telecommunications equipment manufacturing would seriously impede competition, foreclose our domestic equipment marketplace to American companies, cut off the revenue stream that sustains R&D for these American firms and enables them to compete internationally, and gives foreign firms captive markets and guaranteed sales in the U.S. The suggestion that some of the foreign firms involved have U.S.-based facilities is without consequence, for these firms continue to repatriate their profits to their home countries.

In a closely related area, the RBOCs argue that they are restricted by the MJF from fully participating in the provision of so-called "information services," those enhanced telecommunications services such as home shopping or the access of various databases. In fact, the court last year substantially eased the previous restriction in this area, so that the RBOCs are now able to provide all such services. The only thing they may not do is to generate the content, i.e., furnish customers RBOC-originated home

shopping lists, financial or real estate reports, etc. The RBOCs are free to transmit to customers all such services, and they are doing so. To allow the RBOCs to control both the transmission of these sophisticated databases and the content of these sophisticated databases would open the door to anticompetitive conduct and to other dangers as well.

The limitations imposed on the RBOCs by the MFJ are as necessary to fair competition in the telecommunications industry as they were when the MFJ was entered, five years ago. To suggest that any of these restrictions, the manufacturing restriction, in particular, should be removed to promote research and development, technological innovation and job opportunities in the U.S. is doubly wrong, because such action would have just the reverse effects. The U.S. can ill afford to export research funds, skilled scientists and technicians, and jobs to other countries at a time when they are so badly needed here.

Let me again thank the Chairman and the Subcommittee for the opportunity to offer this statement.

TESTIMONY

Subcommittee on Energy Research and Development
Committee on Science, Space and Technology

Submitted by:

James P. Hartnett
Executive Secretary
Midwest Universities Energy Consortium Inc.

P.O. Box 5478
Chicago, IL 60680
312/996-4490

February 10, 1989

My name is James P. Hartnett. I am Professor of Engineering and Director of the Energy Resources Center at the University of Illinois at Chicago. I am also the spokesman for the Midwest Universities Energy Consortium, representing the 20 major research universities in the Big Ten States of Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin (the names and locations of the member institutions are shown on Figure 1).

We in the Midwest share the concern of all Americans about our continuing ability to compete in the world marketplace. We are convinced that we need a strong research base to provide the new ideas that will allow the United States to keep at the forefront of high technology. Against this background I would like to call this committee's attention to a continuing need to bring the nation's universities together with the national laboratories and industry to carry out cost-effective integrated collaborative research programs. Such a university/national laboratory/industry partnership has been recommended by a White House Science Council Report and by DOE's Energy Research Advisory Board. The implementation of this recommendation is especially important at this time when we are attempting to maximize our return on federal dollars.

In response to this national need the Midwest Universities Energy Consortium, Argonne National Laboratory and midwest industry have established an institute to carry out collaborative research in a topical area of major importance to our nation's industries, namely multiphase flow. Multiphase flow involves the simultaneous flow of two or more phases such as steam (gaseous phase) and water (liquid phase) coal particles (solid phase) and air (gaseous phase). Such flows are complex and occur throughout the energy production industry (i.e., petroleum and coal extraction and processing), the coal industry, the steel industry and the automobile industry. Examples of special importance to the Midwest include fluidized bed combustion of coal and coal slurry pipelines. We could build bigger, better and more efficient industrial systems if we had more knowledge about these flows. In brief, an improved understanding of multiphase flow would allow many major national industries to improve their

system designs, increase their overall efficiencies, improve their safety and thus provide a competitive edge which is so critical to the future of American industry.

The funding of the collaborative research effort being carried out by the Multiphase Flow Research Institute is complicated by the fact that the program falls under the jurisdiction of two major offices (Figure 2) within the U.S. Department of Energy:

- o Solid-fluid systems fall under the jurisdiction of Fossil Energy;
- o Liquid-vapor systems fall under the jurisdiction of Basic Energy Sciences.

The total annual support needed to carry out the peer-reviewed research program of the Institute is $10 million, with $5 million needed for each component. To date, we have succeeded in obtaining start-up funding for FY88 and 89 for the solid-fluids program under the budget of the Department of Interior and Related Agencies, Advanced Research and Technology Development. On behalf of the Multiphase Flow Research Institute I respectfully request that the Science and Technology Committee recommend that a total of $5 million be appropriated for collaborative research in solids transport (multiphase flow) as exemplified by the Multiphase Flow Research Institute involving Argonne National Laboratory, the Midwest Universities Energy Consortium and midwestern industry. It is also requested that such funding not be taken out of Argonne National Laboratory's fossil energy budget.

The liquid-vapor portion of the Institute program falls under the jurisdiction of the Engineering Program of the Office of Basic Energy Sciences. As shown in Figure 3 the Engineering budget of $15.4 million represents only 3 percent of the Basic Energy Sciences budget. The conclusion that Engineering is underfunded is obvious. An increase of $5 million is requested in the Engineering budget to cover liquid-vapor systems (multiphase research).

In summary, we are calling to the committee's attention the need to encourage and fund collaborative engineering research, bringing together universities, national laboratories and industry on problems of national importance. We ask for your support for one such effort: the Multiphase Flow Research Institute program. In particular, we request funding for $5 million

Multiphase Flow Research Institute program. In particular, we request funding for $5 million in solids transport (multiphase flow) within the Office of Fossil Energy (DOE) and $5 million for the liquid vapor (multiphase flow) within the Engineering Division of the Office of Basic Energy Sciences (DOE).

On behalf of my university colleagues I wish to express appreciation to the committee for the opportunity to bring this matter to your attention.

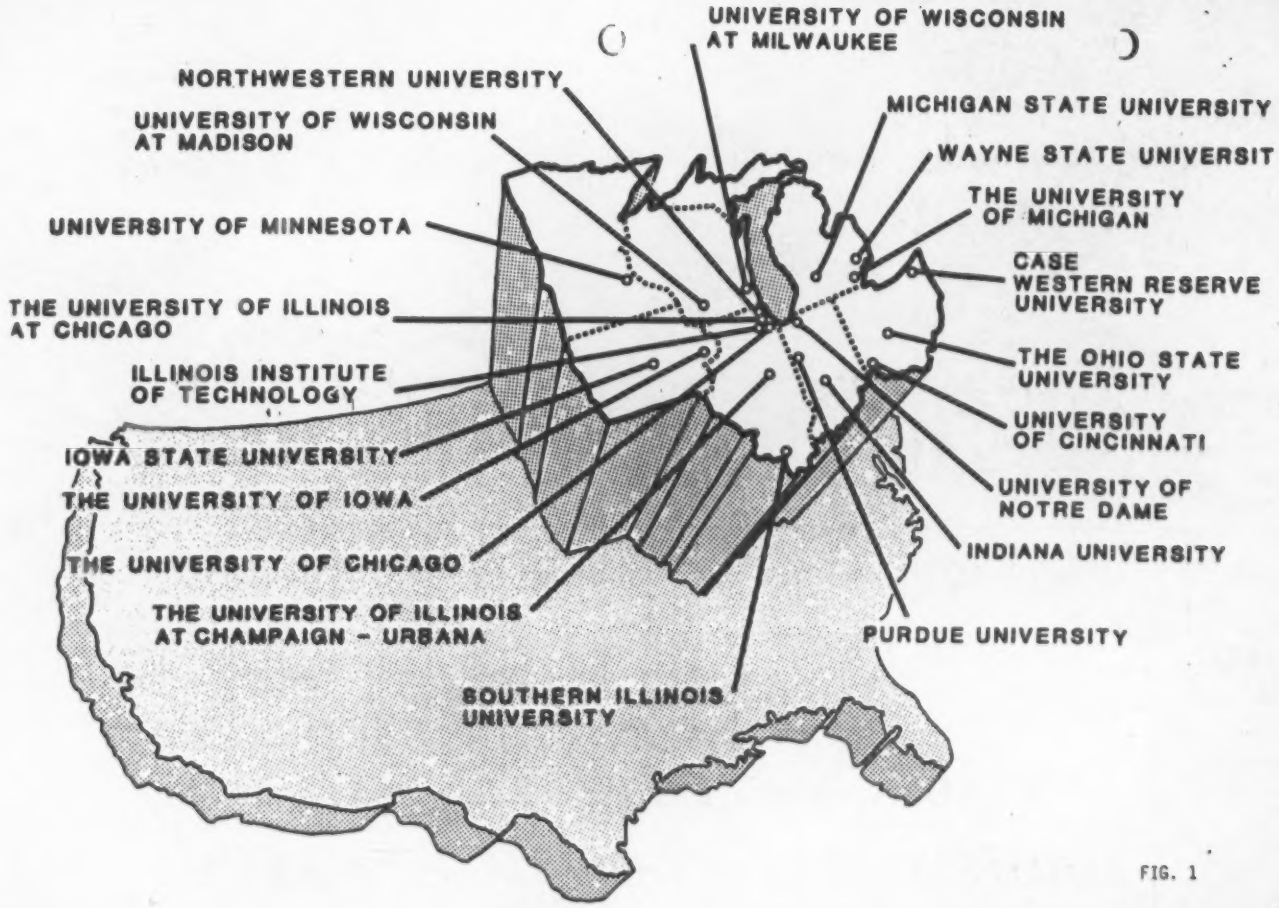
UNIVERSITY OF WISCONSIN
AT MILWAUKEE
NORTHWESTERN UNIVERSITY
UNIVERSITY OF WISCONSIN
AT MADISON
MICHIGAN STATE UNIVERSITY
WAYNE STATE UNIVERSIT
THE UNIVERSITY
OF MICHIGAN
UNIVERSITY OF MINNESOTA
CASE
WESTERN RESERVE
UNIVERSITY
THE UNIVERSITY OF ILLINOIS
AT CHICAGO
THE OHIO STATE
UNIVERSITY
ILLINOIS INSTITUTE
OF TECHNOLOGY
UNIVERSITY
OF CINCINNATI
IOWA STATE UNIVERSITY
UNIVERSITY OF
NOTRE DAME
THE UNIVERSITY OF IOWA
INDIANA UNIVERSITY
THE UNIVERSITY OF CHICAGO
THE UNIVERSITY OF ILLINOIS
AT CHAMPAIGN - URBANA
PURDUE UNIVERSITY
SOUTHERN ILLINOIS
UNIVERSITY

FIG. 1

FUNDING OF MULTIPHASE FLOW INSTITUTE

U.S. DEPARTMENT OF ENERGY

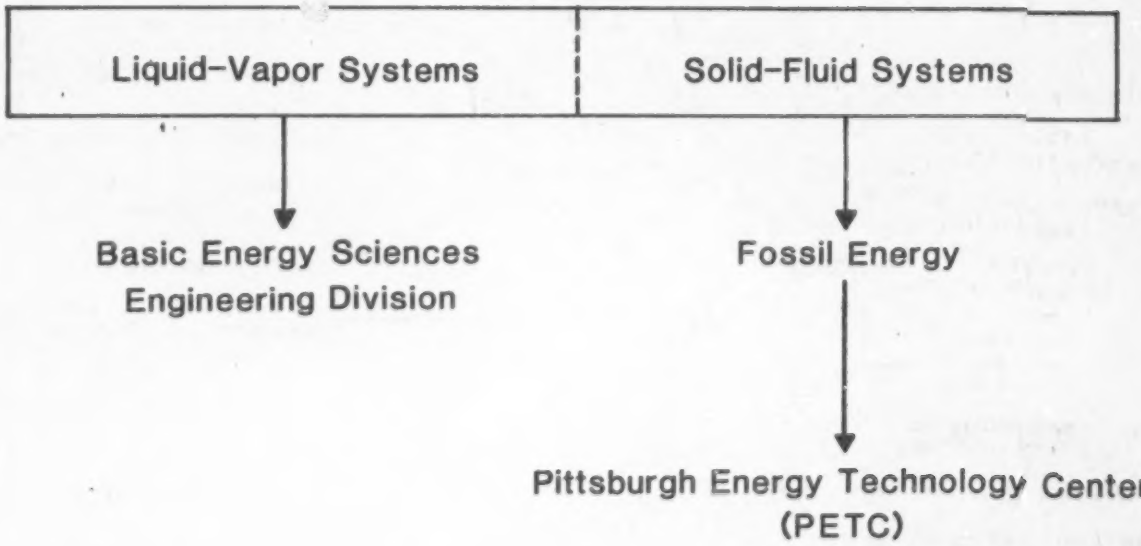

FIG. 2

97-750 (256)

BASIC ENERGY SCIENCES
U.S. DEPARTMENT OF ENERGY

- Basic Energy Sciences
  FY 89 Budget — $ 516 Million

  - Engineering Division — $ 15.4 Million

ENGINEERING IS UNDERFUNDED

FIG. 3